

(12) **UK Patent**

(19) **GB**

(11) **2525516**

(13) **B**

(45) Date of B Publication

22.04.2020

(54) Title of the Invention: **Biometric methods and systems for enrollment and authentication**

(51) INT CL: **G06K 9/00** (2006.01) **G07C 9/00** (2020.01)

(21) Application No: **1510277.5**

(22) Date of Filing: **11.11.2013**

Date Lodged: **12.06.2015**

(30) Priority Data:
(31) **61726014** (32) **14.11.2012** (33) **US**

(86) International Application Data:
PCT/IB2013/060050 En 11.11.2013

(87) International Publication Data:
WO2014/076622 En 22.05.2014

(43) Date of Reproduction by UK Office **28.10.2015**

(72) Inventor(s):
Golan Weiss

(73) Proprietor(s):
Golan Weiss
Moshav Hodaya 74, P.O.B Hof Ashkelon,
Moshav Hodaya 79854, Israel

(74) Agent and/or Address for Service:
Golan Weiss
Beneluxlaan 20, Harderwijk, 3844 AK, Netherlands

(56) Documents Cited:
EP 1912151 A1 **CN 101281600 B**
US2009046331
US2011235872

(58) Field of Search:
As for published application 2525516 A viz:
INT CL **G06F, G06K, G07C**
Other: **G06K 9/00; G07C 9/00; G06F 21/32**
updated as appropriate

Additional Fields
Other: **None**

GB 2525516 B

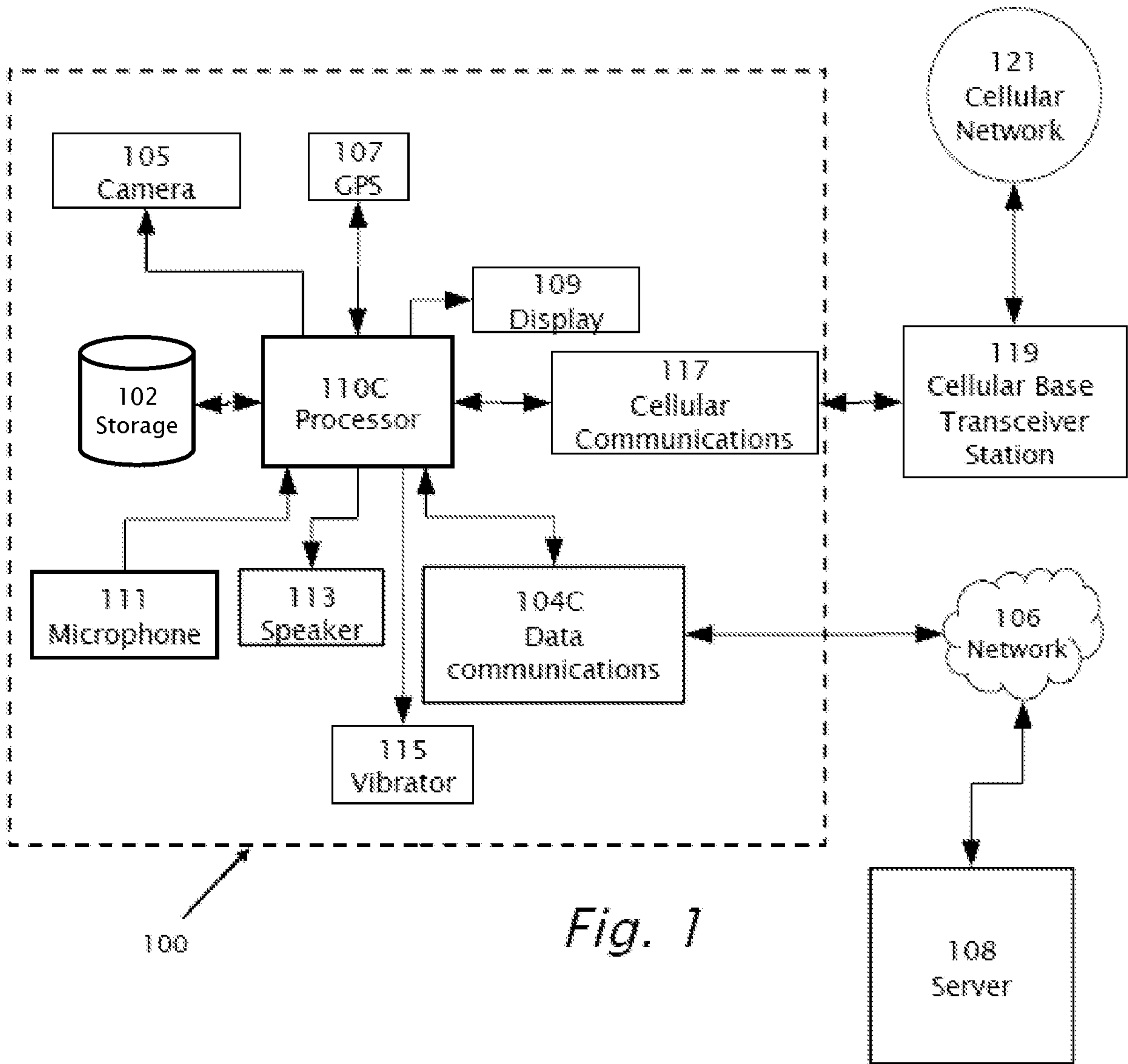
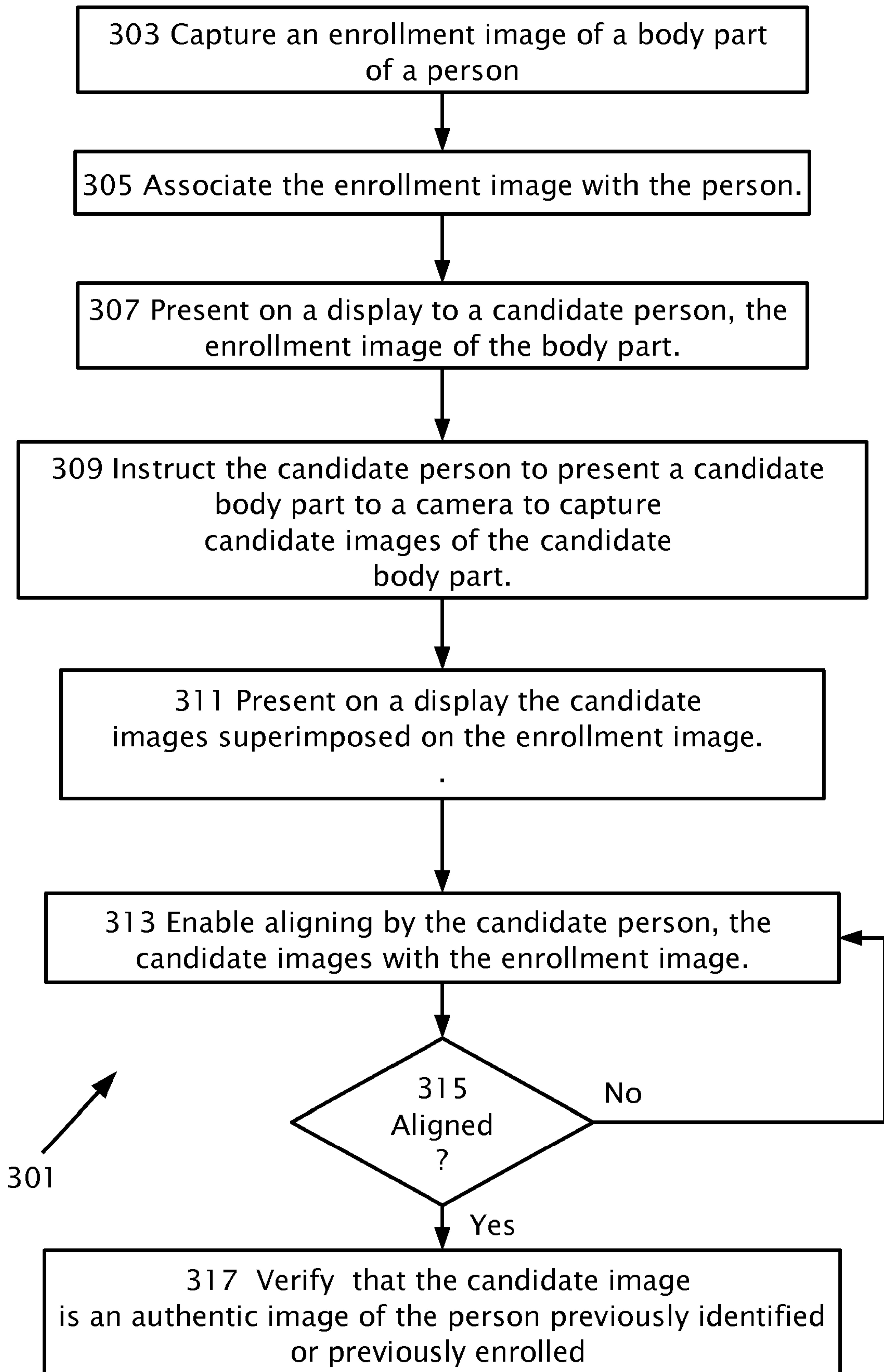


Fig. 1

*Fig. 2*

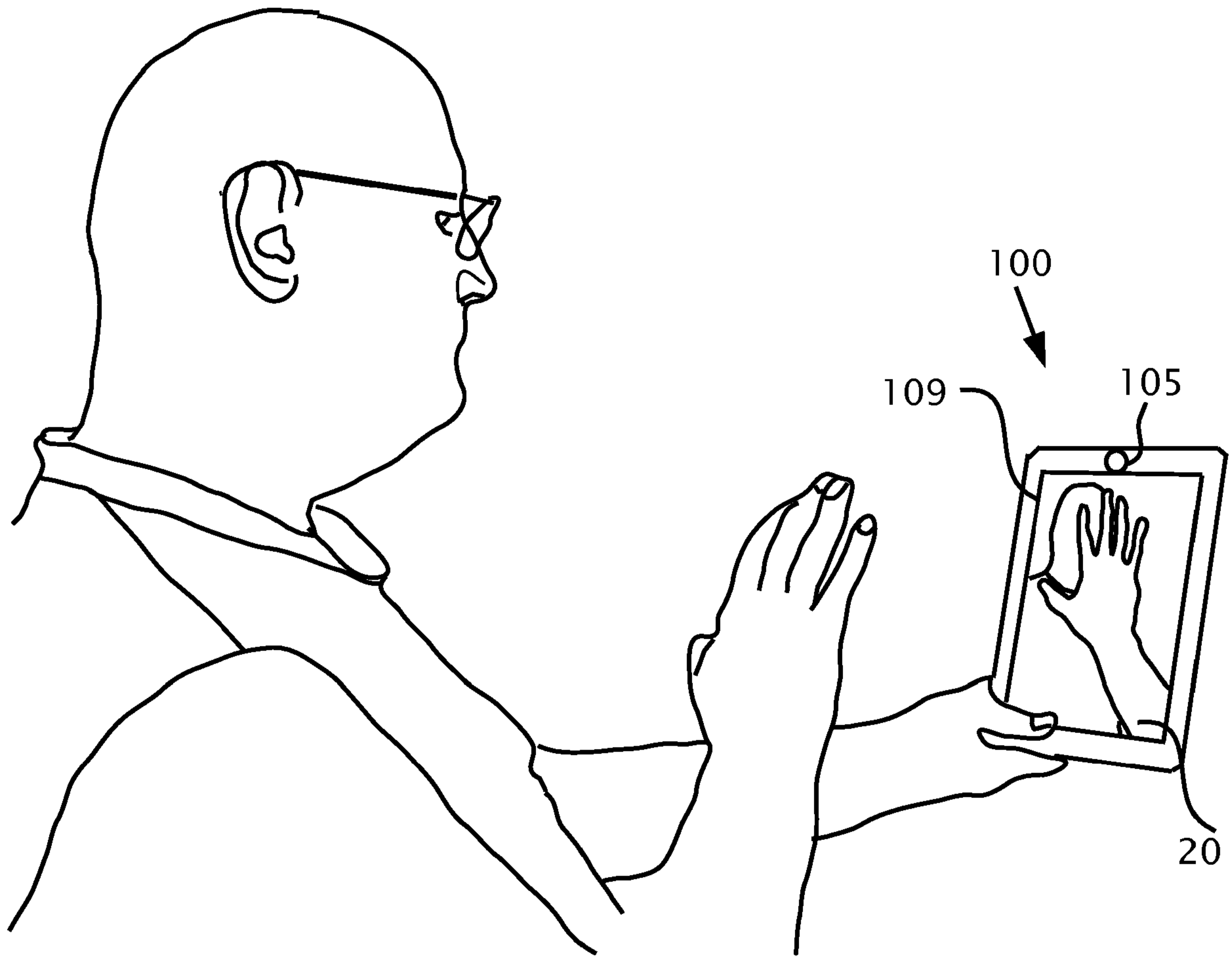


Fig. 2a

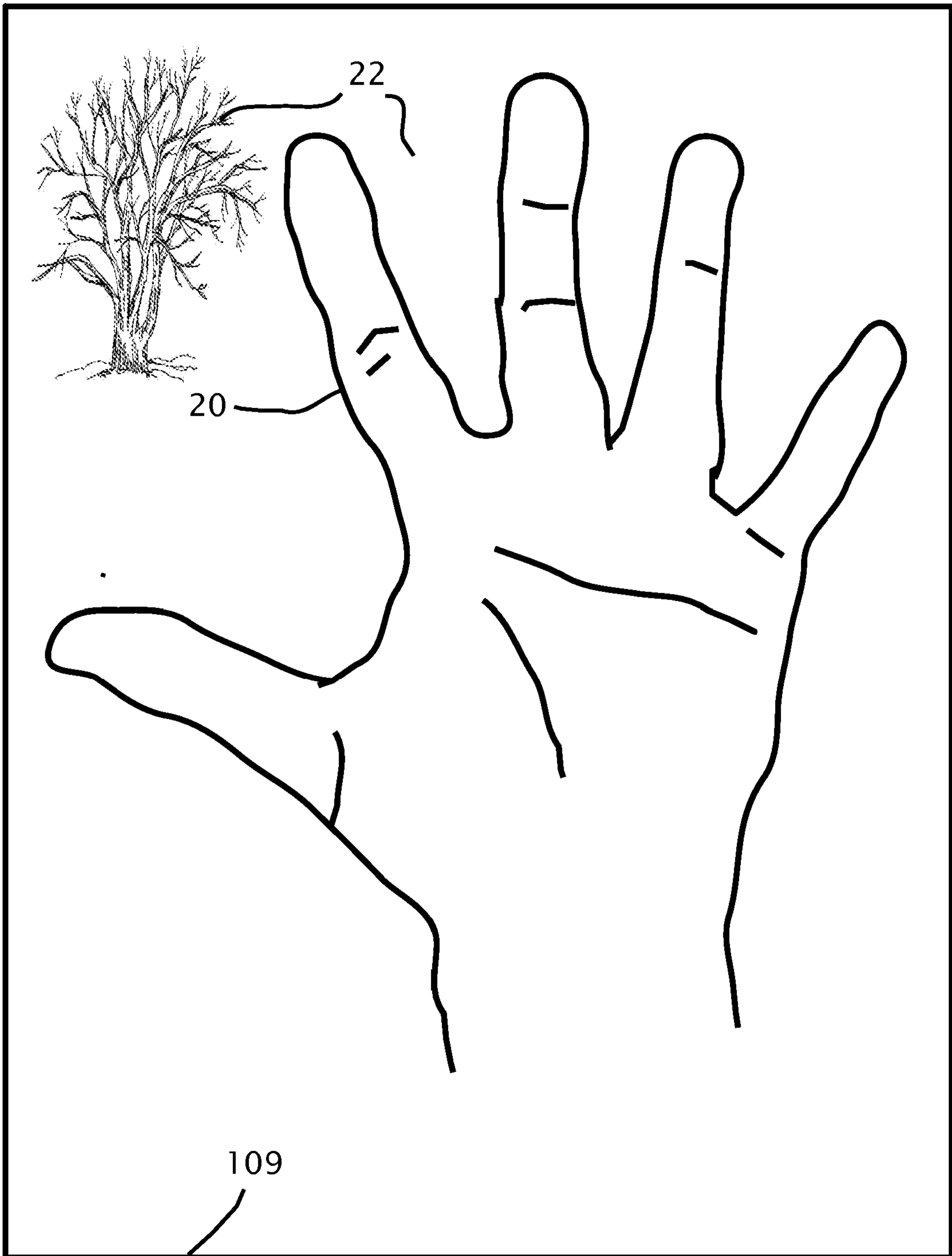


Fig. 3

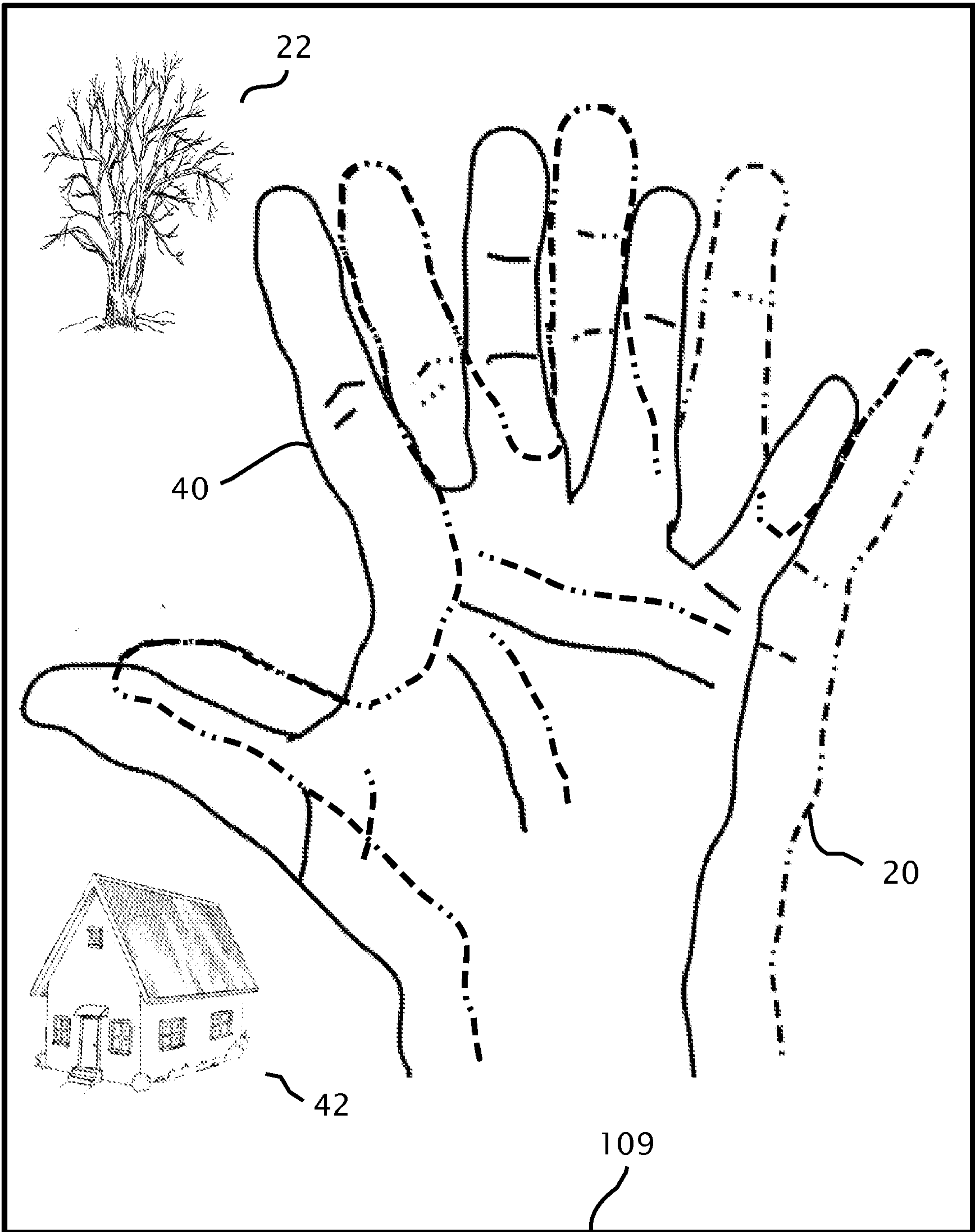
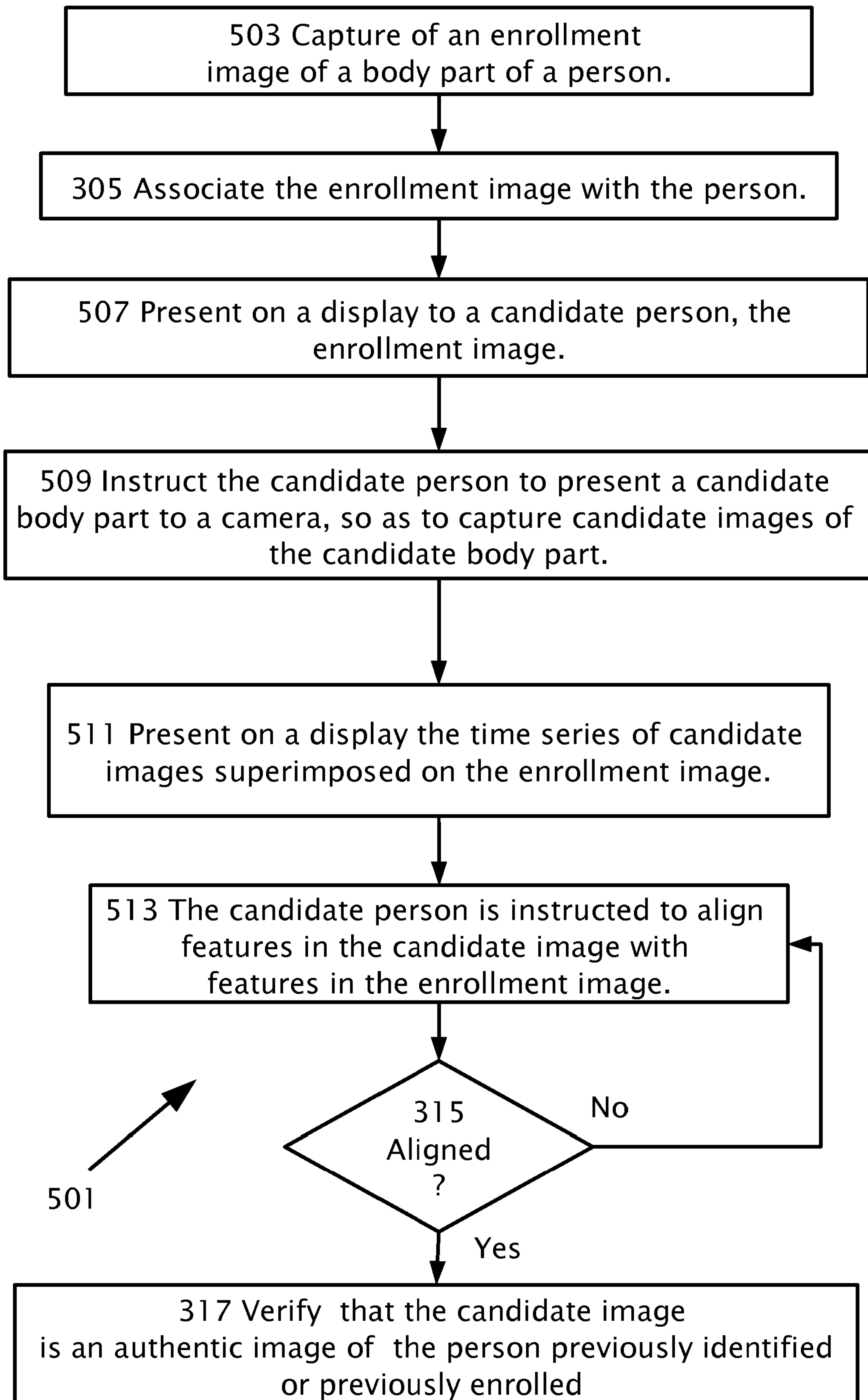
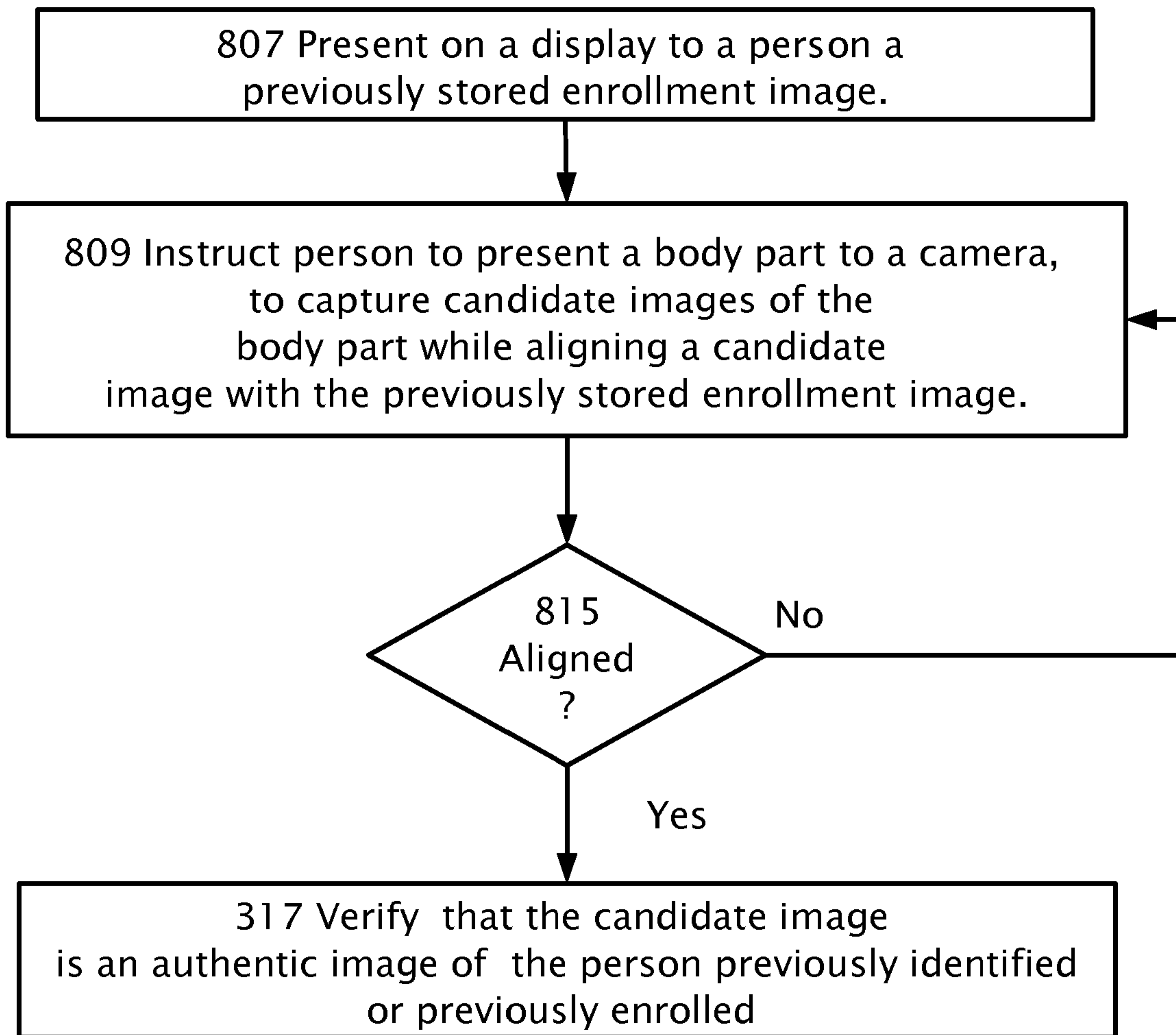


Fig. 4

*Fig. 5*



801 ↗

Fig. 6

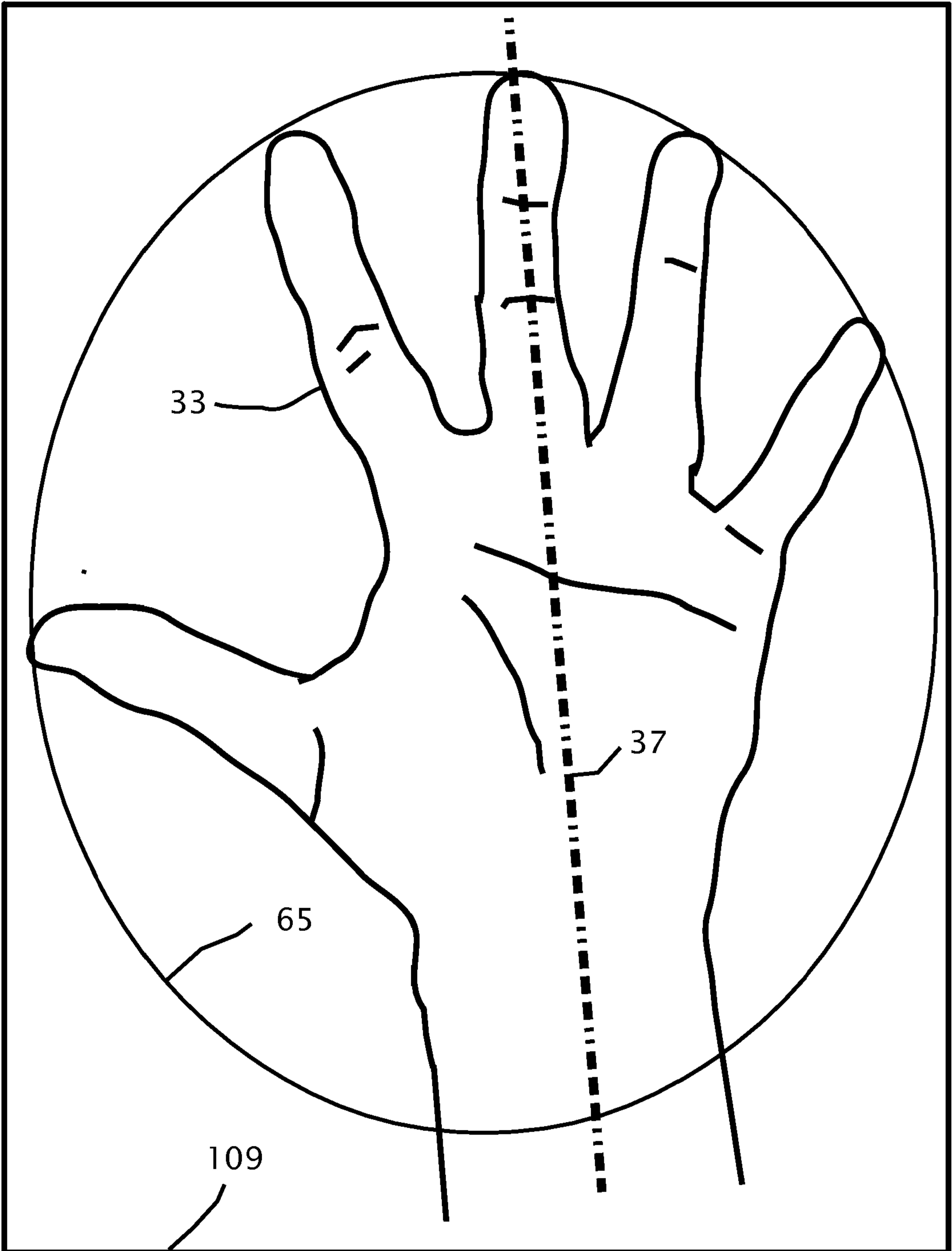


Fig. 7

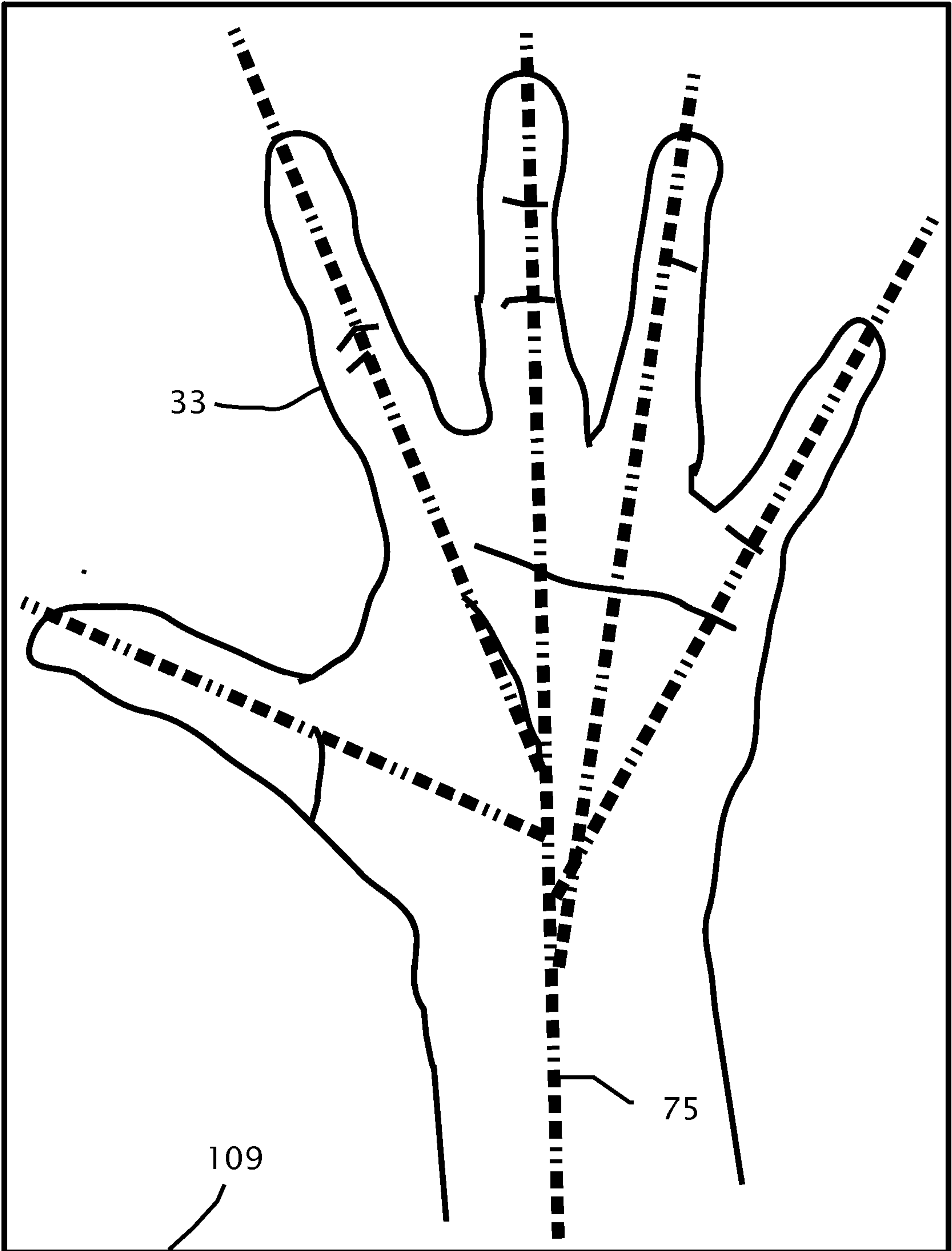
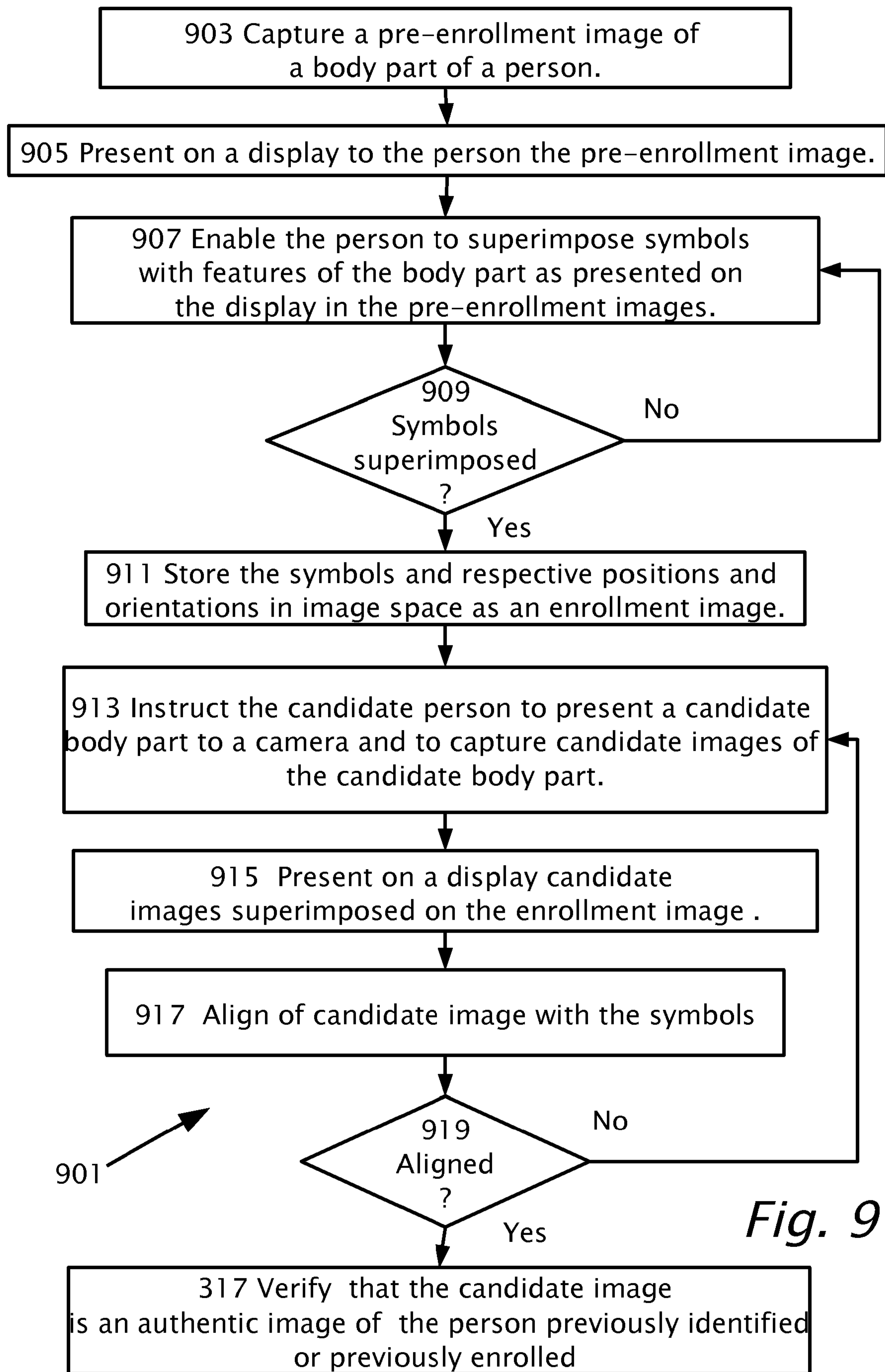


Fig. 8

10/17



901 →

Fig. 9

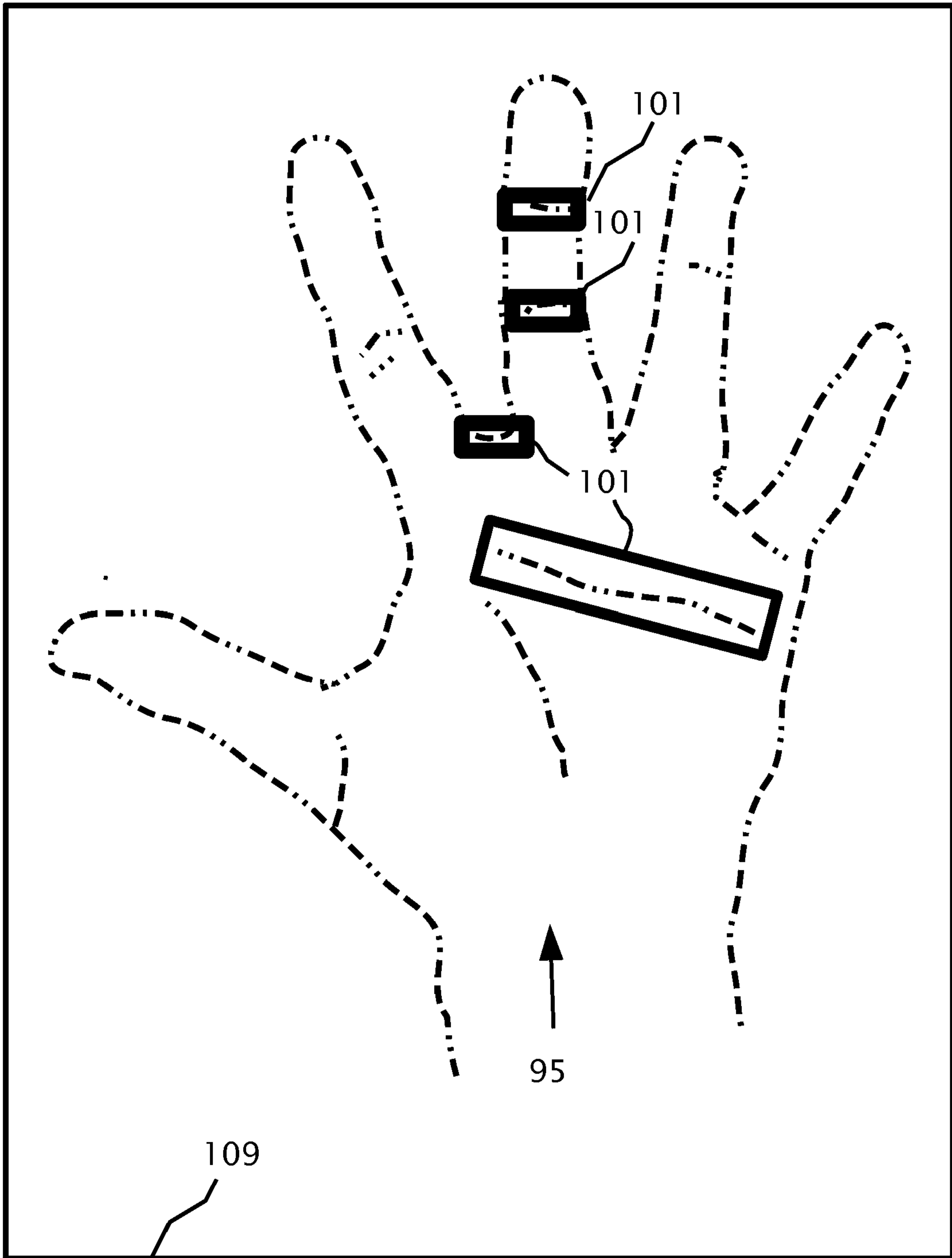


Fig. 10a

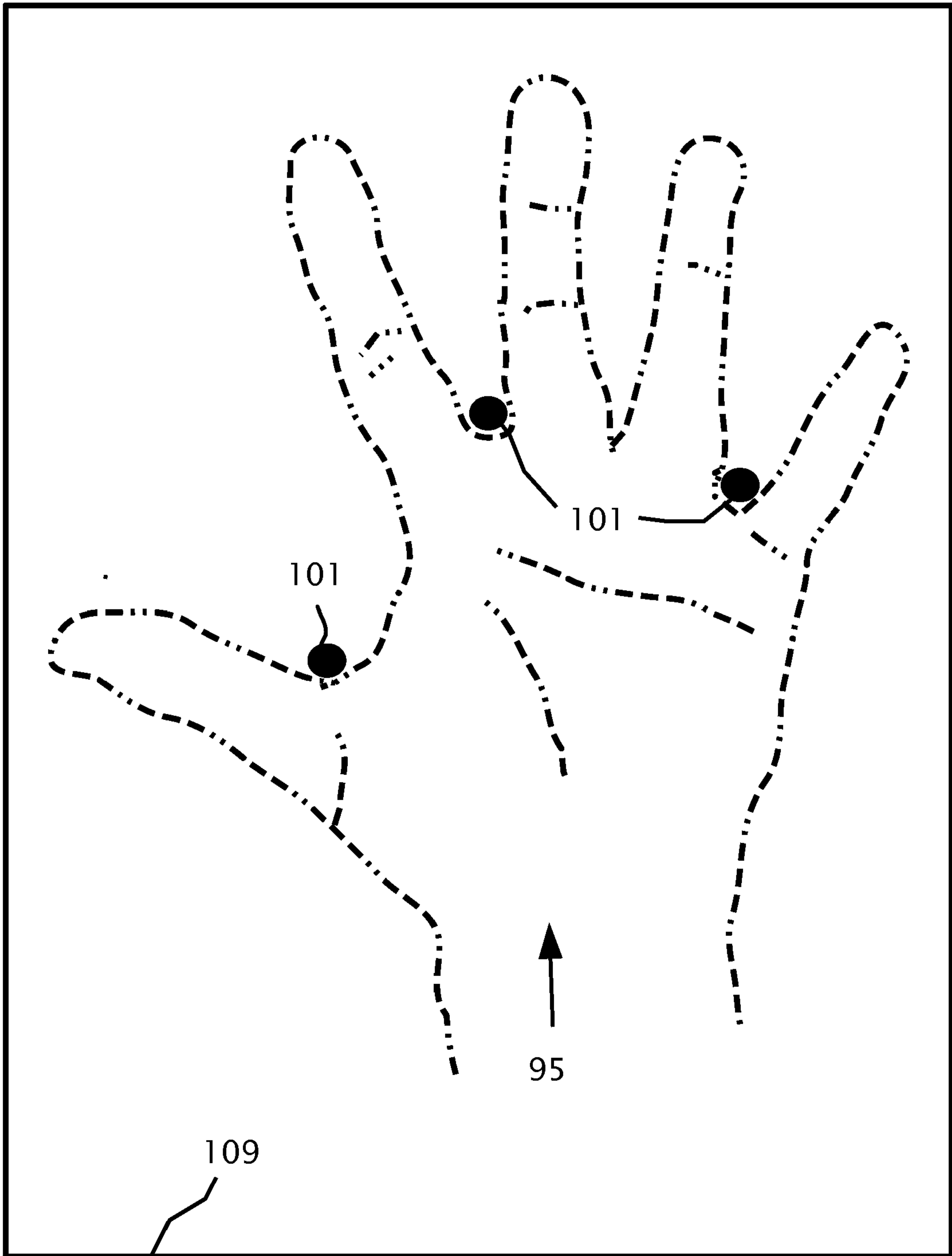
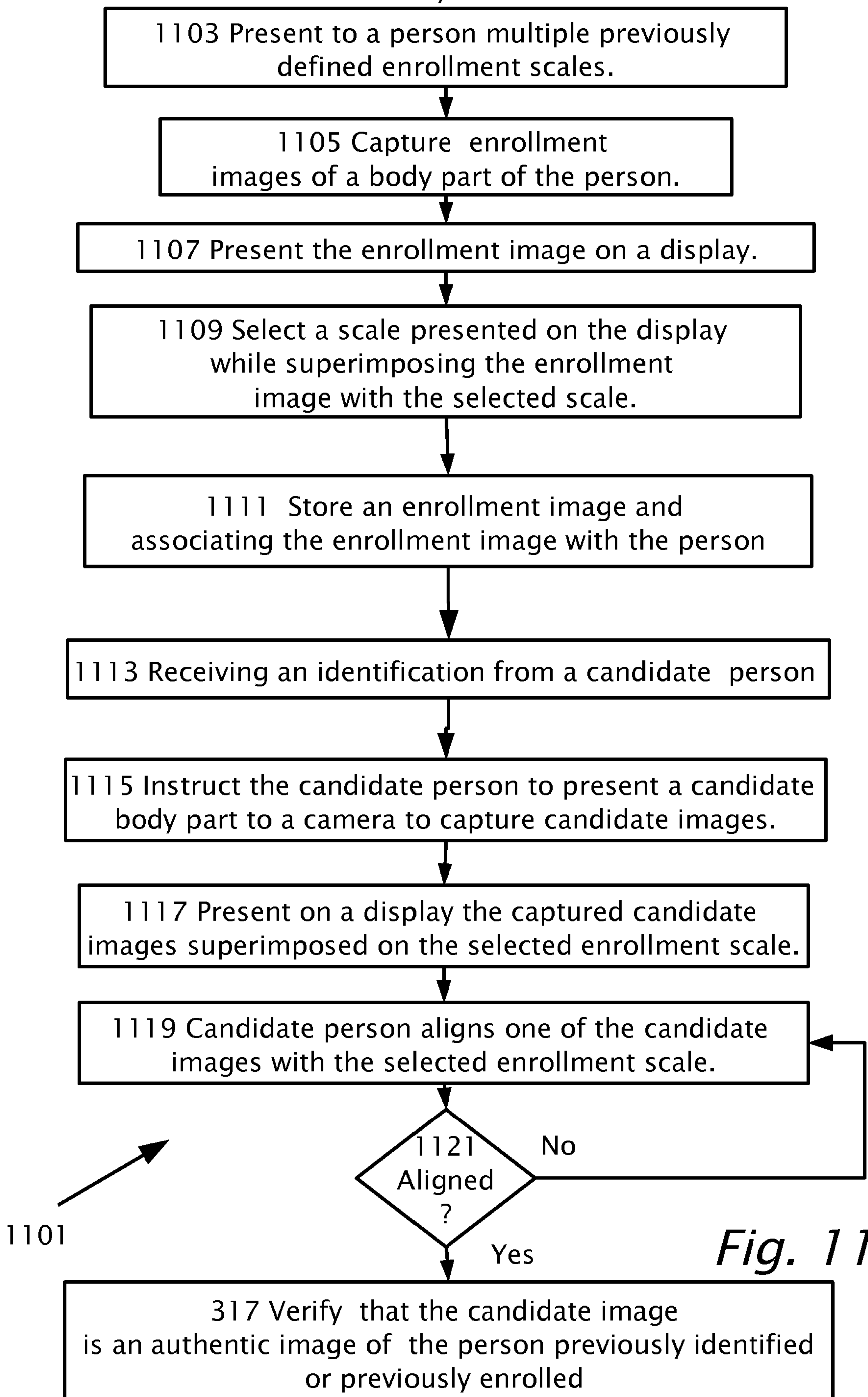


Fig. 10b

13/17



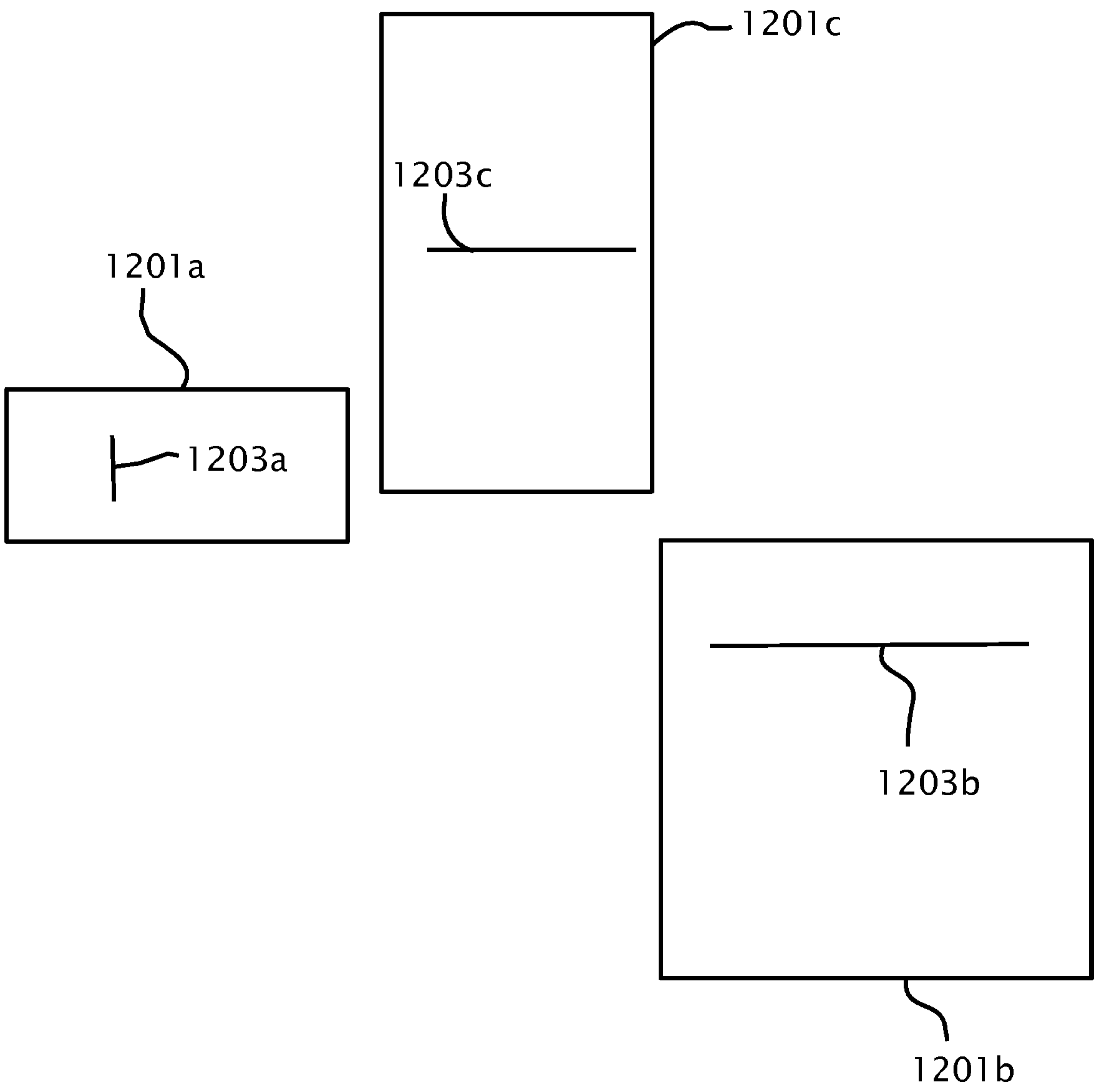


Fig. 12

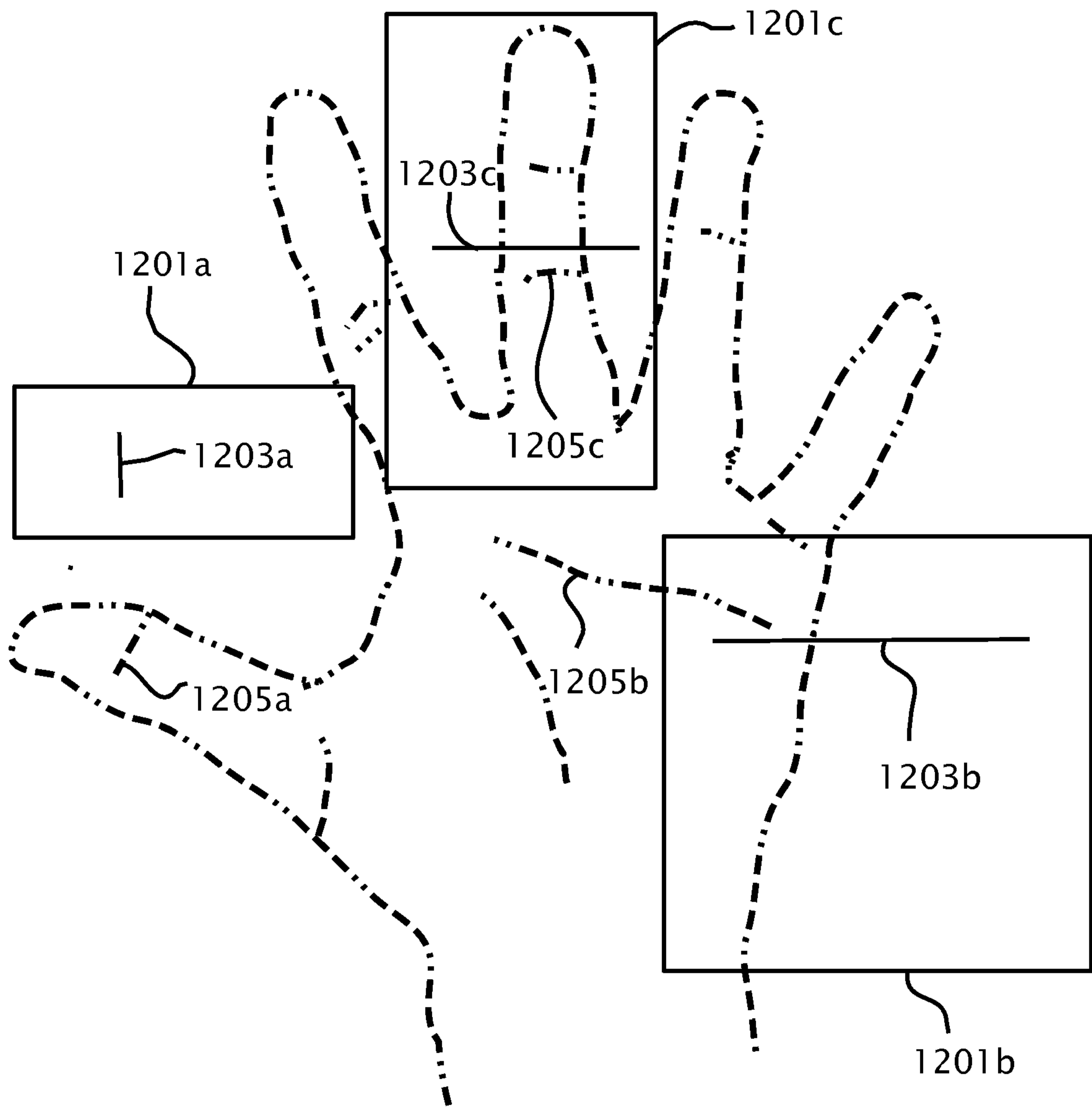


Fig. 13

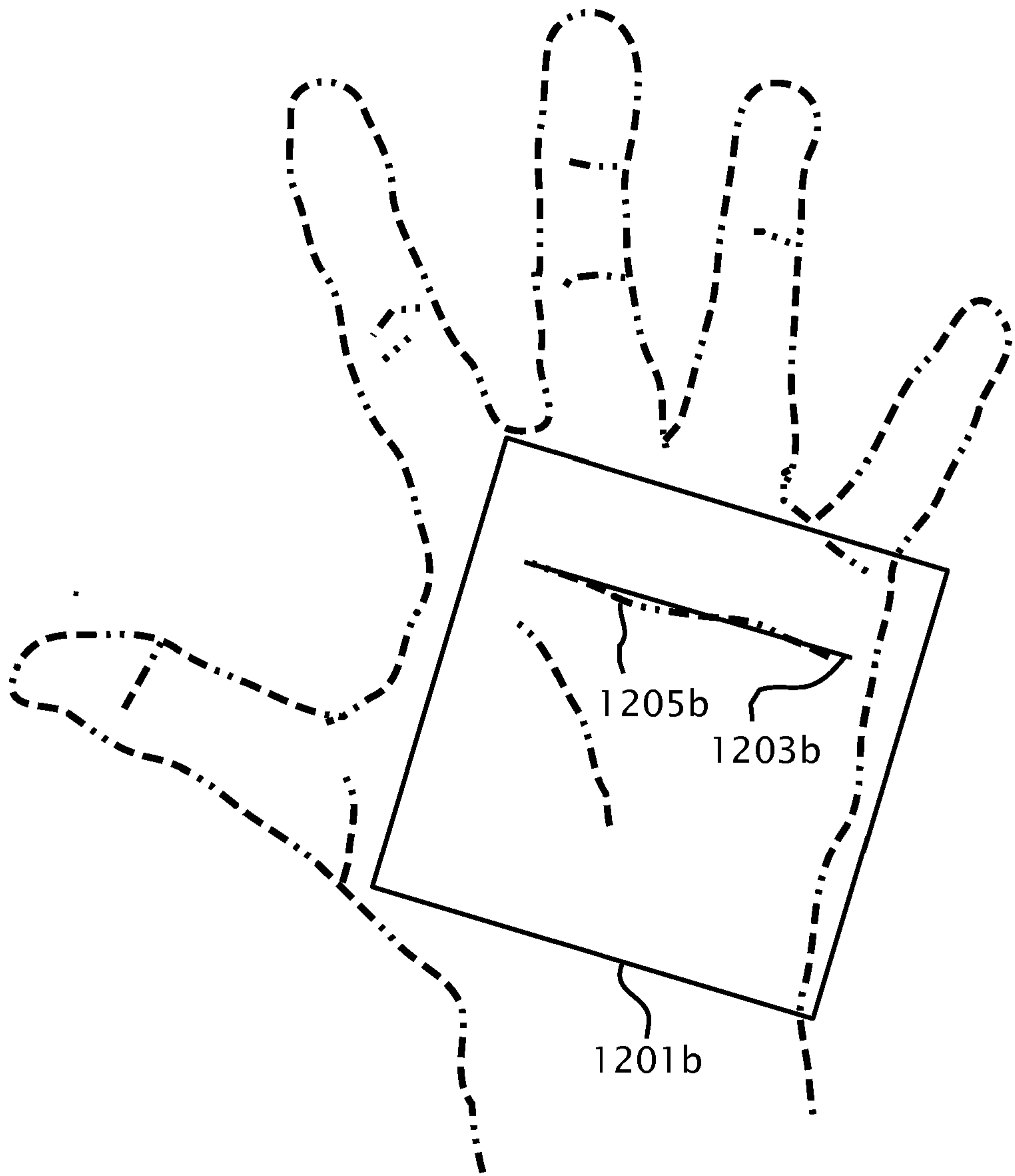


Fig. 14

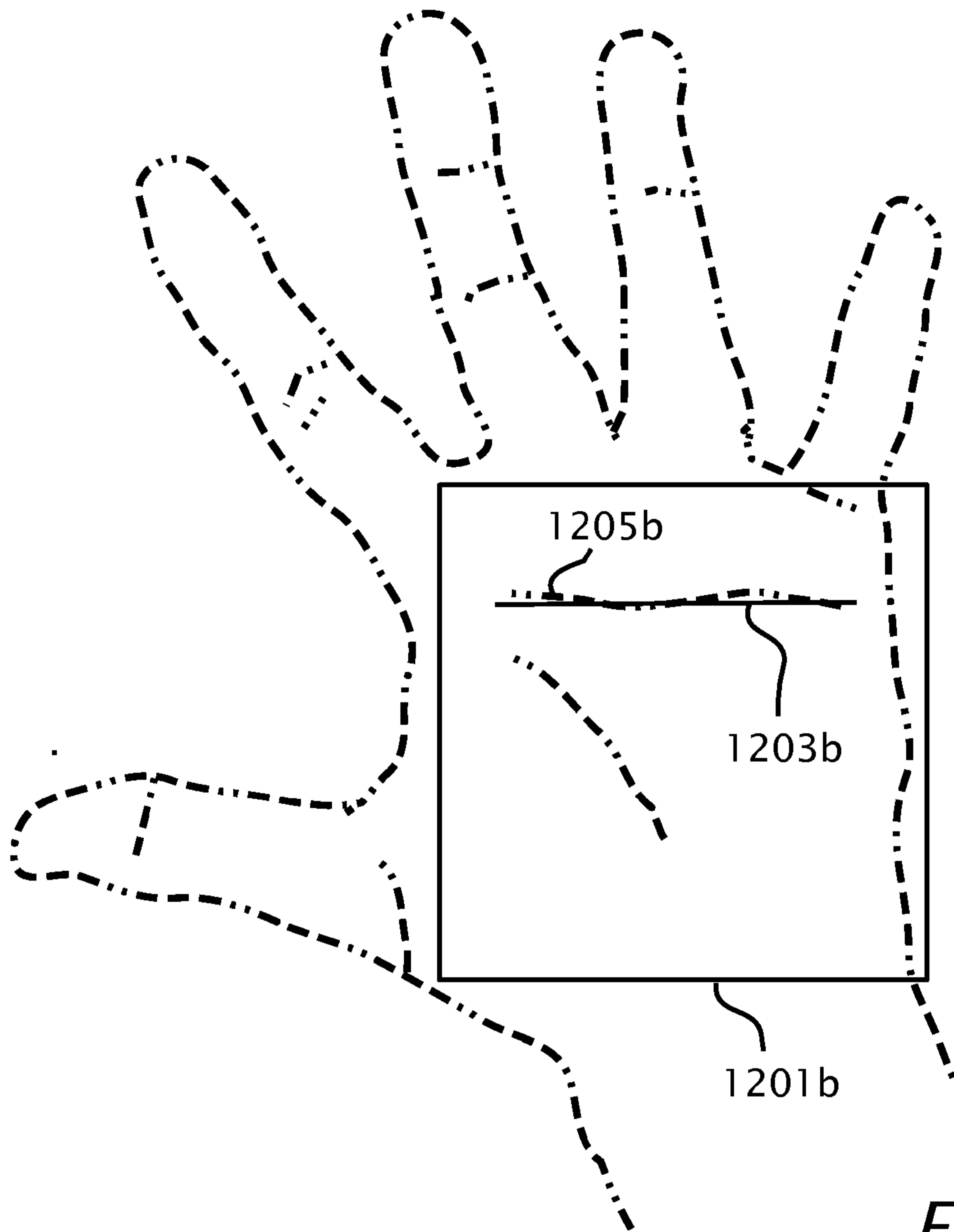


Fig. 15

BIOMETRIC METHODS AND SYSTEMS FOR ENROLLMENT AND AUTHENTICATION

BACKGROUND

1. Technical Field

5 The field of the present disclosure relates to biometric methods for enrollment and authentication of a person using a camera and a display.

2. Description of Related Art

Many resources have been invested into developing reliable schemes for identity verification in order to prevent fraud in electronic commerce. Existing methods for
10 identity verification may rely on an item that the person possesses, such as a smart card or a datum that the person knows, such as a password, personal identification number (PIN) or other information.

Considerable effort has been invested in identity verification using biometrics, based on physiological and/or behavioral characteristics. Characteristics used for biometric
15 authentication may include fingerprint, retina or iris scanning, voice, signature, and/or face.

US patent 7,327,858 discloses biometric authentication using prominent lines of the hand when scanned by a scanning unit such as a scanner with a planar platen.

20 BRIEF SUMMARY

Various computerized biometric methods for enrollment and authentication of a person are provided for herein. During authentication, a previously stored enrollment image is presented on a display to the person. A candidate person is instructed to present a body part to a camera while the person is holding the body part unsupported in free space with
25 respect to the camera. Using the camera, a candidate image of the body part is captured and presented with the previously stored enrollment image. The candidate person aligns the candidate image with the previously stored enrollment image. On alignment, the candidate image is verified as an authentic image of the person and the candidate person

is authenticated as the person previously enrolled. The previously stored enrollment image may be generated independently from the person. The same enrollment image may be displayed for the enrollment of multiple previously unenrolled persons.

During the enrollment, a person may hold a body part unsupported in free space with respect to the camera. The camera may be used to capture the enrollment image of the body part and background thereof. The authentication may include capturing the time series of the candidate images of the candidate body part and background thereof. Alternatively, an enrollment image is captured from a medium such as a passport, drivers license, identity card or other document used for identification.

10 During the capture, the time series of candidate images is presented on a display superimposed on the enrollment image with the respective backgrounds thereof.

The body part may a portion of a face, a hand, at least an ear, and/or an eye. The candidate person may align a feature of the body part in the candidate images with a corresponding feature in the enrollment image. The feature and the corresponding feature may be: a line, a ridge, a beauty mark, a scar, a mole, an area of differing skin pigmentation, a birth mark and a wrinkle.

Verification may be performed by comparing the enrollment image with the authentication image. The alignment may include alignment in horizontal, vertical image coordinates, angular orientation in image space, and real space distance to camera.

20 Prior to presentation of the previously stored enrollment image, the enrollment image may be processed by performing horizontal mirror inversion of the enrollment image.

The candidate person may be instructed to align a feature of the body part in the candidate images with a corresponding feature in the enrollment image. Upon the candidate person aligning the feature of the body part in the candidate image with the corresponding feature in the enrollment image, one or more of the candidate images is verified as an authentic image of the candidate person. One or more candidate images may be authenticated thereby as an authentic image of the candidate person. The candidate person is then authenticated as the person previously enrolled by comparing the feature in the candidate image with the corresponding feature in the enrollment image.

A pre-enrollment image of a body part may be captured while the person is holding a body part of the person unsupported in free space with respect to the camera. The pre-enrollment image may be presented to the person on a display. Upon presentation of the pre-enrollment image, the person may superimpose symbols with imaged features of the body part as presented on the display. Upon superimposing the symbols with the imaged features of the body part, the enrollment image is stored with the symbols and respective positions and orientations of the symbols in image space in the pre-enrollment image. Prior to the superimposition, the symbols may be relocated, re-sized and/or rotated. The presentation on the display to the candidate person of the enrollment image may include the stored symbols and at least a portion of an image of the body part. Alternatively, the presentation on the display to the candidate person of the enrollment image may include presentation of the stored symbols without any portion of an image of the body part.

Multiple previously defined enrollment scales may be presented on a display to the person. The person may select one or more of the scales presented on the display to produce thereby a selected enrollment scale. The person may superimpose and/or reposition one of the enrollment images with the selected scale. The selected scale may be stored as an enrollment image. The authentication includes presentation on a display of the time series of the candidate images superimposed on the selected enrollment scale

The candidate person may align the candidate images with the selected enrollment scale.

During the authentication, the presentation of the enrollment scale to the person may include multiple enrollment scales and the candidate person may select person the selected enrollment scale.

Various mobile computer systems are provided herein enabled to perform the computerized biometric methods as disclosed herein, wherein the camera and the display are parts of the mobile computer system.

Various computer readable media are provided for herein encoded with processing instructions for causing a processor to execute the methods disclosed herein.

The foregoing and/or other aspects will become apparent from the following detailed description when considered in conjunction with the accompanying drawing figures.

The invention is herein described, in a non-limiting manner, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 illustrates a simplified block diagram of a mobile computer system, for operation of different features of the present invention.

Figure 2 shows a flow diagram of a method, according to a feature of the present invention.

Figure 3 shows an enrollment image presented on a display with a background also captured according features of the present invention.

Figure 4 shows enrollment and authentication images superimposed with respective backgrounds, according to the method illustrated in Figure 2.

Figure 5 which illustrates another method of biometric enrollment and authentication, according to a feature of the present invention.

Figures 6 and 7 show examples of previously stored enrollment images respectively on a display, according to a feature of the present invention.

Figure 8 shows a flow diagram of a method, including different features of the present invention.

Figures 9 and 10 show a flow diagram of a method and an enrollment image respectively, according to different features of the present invention.

The foregoing and/or other aspects will become apparent from the following detailed description when considered in conjunction with the accompanying drawing figures.

DETAILED DESCRIPTION

Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below to explain the present invention by referring to the figures.

The term "registration" as used herein refers to spatial alignment of image features of different images captured at different places and/or times of similar or identical objects in different image frames.

The term "identification" as used herein refers to receiving initial information, name, identity card number or other information useful for uniquely identifying the user which a user presents prior or during enrollment.

The term "enroll" or "enrollment" as used herein refers to an initiation of a user in the biometric system during which biometric information is received and stored for later identity verification or authentication. The term "enrollment image" refers to image capture during enrollment

The term "authentication" as used herein refers to a biometric verification that the user is who he/she is claimed himself/herself to be during identification.

10 The term "verification" as used hereinafter refers to authentication or denial of authentication based on biometric image features of the candidate person as one of the previously enrolled persons or the previously identified person.

The term "superimpose" as used herein in the context of presenting two or more images simultaneously on a display includes either (i) combining two or more images using image processing techniques and presenting the combined image and/or (ii) presenting to the user alternatively two or more images so that the appearance to the user is that of a combined superimposed image.

The term "body part" as used herein for use in biometric enrollment and authentication may include: a hand, an eye, an ear, a nose or a facial profile or portions thereof of the person.

20 The articles "a", "an" is used herein, such as "a candidate image", "an enrollment image", "a background" have the meaning of "one or more" that is "one or more candidate images", "one or more enrollment images" and "one or more backgrounds".

By way of introduction, different embodiments of the present invention may find use in a number of different biometric methods to identify and enroll a user in the system and subsequently authenticate a candidate person as one of the previously enrolled users. Embodiments of the present invention are intended to be used with a camera and a two-dimensional or three dimensional display as may be available in a mobile computer system, *e.g.* smart-phone. In some embodiments of the present invention, the user during enrollment presents unsupported in free space a body part, *e.g.* hand, and an enrollment

image is captured. Subsequently, the person when for instance he/she desires to perform an Internet transaction, for example, presents the same body part, *e.g.* hand, and an authentication image is captured also with the hand unsupported with free space between the camera and hand. The authentication image may be processed to be of the same hand
5 as used for the enrollment image and authentication is achieved, or otherwise authentication is denied.

When an enrollment image is used again for authentication, the enrollment image when presented for authentication purposes may be distorted, warped, filtered, blurred, manipulated in gray scale or color, resolution reduced, partially displayed or otherwise image processed, to render it difficult for an imposter to reconstruct an authentication image from the enrollment image when presented during authentication.

In various embodiments of the present invention to be presented in further detail, authentication may be in a different location and/ or time or date or using a different computer system from enrollment, and any body part may suitable for biometric
10 enrollment and authentication.

The processing for authentication and verification of identity may be similar to the processing techniques disclosed in US 7,327,858 such as by comparing specific features between the enrollment and authentication images. The features used in US 7,327,858 are the prominent lines of the hand. However, according to prior art methods, before the
15 actual authentication processing may be performed, image registration is performed during which the respective images of the same features of interest are located in both the enrollment image and authentication image.

Various embodiments of the present invention are intended to avoid or facilitate image registration between the common imaged features of interest in the enrollment image and
20 in the authentication. Avoiding or facilitating image registration to reduce the computational burden on the processor being used and/or decrease computational time required.

Thus there is a need for and it would be advantageous to have methods and systems useful for avoiding and/or facilitating image registration between enrollment images and

authentication images to enable biometric authentication of using image capture of unsupported body parts held in free space.

Although in some embodiments of the present invention a mobile computer system is used for enrollment and authentication, in other embodiments a non-mobile computer system and otherwise a dedicated computer system may also or alternatively be used.

Before explaining embodiments of the invention in detail, it is to be understood that the invention is not limited in its application to the details of design and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

Referring now to the drawings, Figure 1 illustrates a simplified block diagram of a mobile computer system **100** according to features of the present invention. Mobile computer system **100** is connectible over a network **106** to a server **108**. Mobile computer system **100** is also connectible through a cellular base station transceiver **119** to cellular network **121**. Mobile computer system **100** includes a processor **110C** connected to local data storage **102**. A data communications module **104C** operatively connects processor **110C** to data network **106**. A cellular communications module operatively connects processor **110C** to cellular network **121**. Mobile computer system **100** may include operatively connected to processor **110C** peripheral accessory devices such as a display **109**, global positioning system **107**, a camera **105**, a microphone **111**, a speaker **113**, a vibrator **115** and accelerometer /gravity sensor, Bluetooth™, IR sensor (not shown).

Reference is now made to Fig 2 which shows a method **301** of biometric enrollment and authentication, according to a feature of the present invention. Method **301** includes steps **303**, **305** for enrollment of a person and steps **307-317** for authentication/non-authentication or verification of a person. In step **303**, an image of a body part, *e.g.* hand of a person is captured, using camera **105** of mobile computer system **100** for instance, to capture an enrollment image of the body part.

Reference is now also made to Figure 2a which shows a person holding her hand in free space with respect to the camera **105** and/or display **109** (of an IPAD™ for example, being used as an example of a mobile computer system **100**). Display **109** shows an enrollment image **20** of the palm, wrist plus arm of the person and the background which includes the face and torso of the person. Camera **105** and/or display **109** may be mounted on a stand so that both hands of the person are free. Figure 2a is by way of example, another body part such as an ear or an eye may be captured to provide enrollment image **20**. Alternatively, enrollment image **20** captured by camera **105** and/or a scanner may be of a picture on; a passport, drivers license, identity card or other document used for identification purposes.

Reference is now made to Figure 3 which illustrates enrollment image **20** presented for example on display **109** of mobile computer system **100**. A feature according to embodiments of the present invention includes avoiding processing to find the contour of enrollment image **20** of body part, *e.g.* hand; hence in Figure 3, the image of the hand is presented with the background captured during enrollment. Background is shown schematically with an image **22** of a bush in Figure **109**.

Referring back to Figure 2, in step **305** an enrollment image **20** is associated with the person. The association of the enrollment image **20** with the person may include the name of the person, date of birth of the person, an identification (ID) number or national insurance or social security number of the person.

Step **307** begins an authentication/non-authentication process of the person previously enrolled. Authentication may be in a different location and/or time or date or using a different computer system from enrollment steps **303-307**.

Reference is now also made to Figure 4 which illustrates display **109** during authentication. In step **307**, enrollment image **20** is presented on display **109** along with background image **22**.

Referring back to Figure 2, in step **309**, a candidate person is instructed to present the body part, *e.g.* hand, to a camera **105** and a time series, *e.g.* video, of candidate images **40** are captured of the hand of the candidate person. Candidate images **40** may include image

of the candidate body part of the candidate person as well as respective background images **42**. According to a feature of the present invention, as in enrollment image **20**, candidate images **40** are presented with respective backgrounds while avoiding finding the contour of the image of the body part to extract and present an image of the body part
5 without background. In Figure 4, background of candidate image **40** of hand is shown schematically with the image **42** of a house.

Still referring to Figure 2, in step **311**, the time series of candidate images **40** are displayed on a display **109** while capturing (step **309**) along with enrollment image **20** previously captured in step **303**. Therefore in step **311**, one or more candidate images **40**
10 are superimposed on the enrollment image **20** with the respective backgrounds **42** and **22**.

In step **313**, the candidate person aligns, i.e. positions and repositions the body part, *e.g.* hand, in front of camera **105** so that one or more candidate images **40** align with enrollment image **20** on display **109**.

To enable alignment in step **313**, enrollment image **20** and or candidate images **40** after
15 being captured (step **303**), may be processed such as with horizontal mirror inversion prior to display (step **311**) on display **109**.

The basis for alignment in step **313** is a feature of the body part in the candidate images **40** with a corresponding feature in the enrollment image **20**. The feature and the corresponding feature may be a ridge, a line, a scar, an area of differing skin
20 pigmentation, a birth mark or a wrinkle on the body part or candidate body part respectively. Alignment step **313** includes alignment in horizontal, vertical image coordinates, angular orientation in image space, and real space distance to camera **105**.

In decision block **315** when one or more candidate images **40** are aligned with the enrollment image **20** on display **109**, verification step **317** may be performed. During
25 verification, (step **317**), the candidate person may be verified as a previously enrolled person and/or previously identified person in steps **303-305** by comparing the enrollment image **20** with an authentication image previously stored according to any techniques known in the art of image processing.

In decision block **315** when one or more candidate images **40** are not yet aligned with the enrollment image **20** on display **109**, alignment continues in step **313** by the candidate person.

Reference is now made to Fig 5 which illustrates another method **501** of biometric enrollment and authentication, according to a feature of the present invention. Biometric method **501** includes steps for enrollment and authentication of a person. In step **503**, a body part of a person is captured using camera **105**, to produce an enrollment image **20** of the body part, *e.g.* hand. In step **305** the enrollment image **20** is associated with the person. Step **507** begins an authentication stage, the enrollment image **20** is presented on a display **109** with or without background **22**. In step **509**, a candidate person is instructed to present his/her hand for example, to a camera **105** and a time series of candidate images **40** are captured of the body part, *e.g.* hand of the candidate person. Candidate images **40** includes an image of a candidate body part of the candidate person presented with or without background image **42**.

In step **511** the time series of candidate images are displayed on a display **109** during capturing (step **509**) along with display of the enrollment image **20** (with or without background **22**) previously captured in step **503**. In step **511**, the candidate images **40** are superimposed on the enrollment image **20**.

In step **513**, the candidate person is able to align, position and reposition his/her hand in front of camera **105** so that candidate images **40** are aligned with enrollment image **20** on display **109**.

In order to facilitate alignment, enrollment image **20** and/or candidate images **40** after being captured (step **503**), may be processed with horizontal mirror inversion prior to display on display **109**.

The basis for alignment in step **513** is : an image of a feature of the body part in candidate images **40** with a corresponding image of a feature in the enrollment image **20**. The feature and the corresponding feature may be a ridge, a line, a scar, an area of differing skin pigmentation, a birth mark or a wrinkle on the body part or candidate body part respectively. The term "feature" as used herein in the context of alignment of a body

part excludes "contour" or the outer edge the body part. Alignment in step **513** may be performed without aligning imaged contours of the body part. The image contours are not necessarily visible on display **109** for candidate images **40** and/ or enrollment image **20**. Alignment step **513** of an image feature includes alignment in horizontal, vertical image
5 coordinates, angular orientation in image space, and real space distance to camera **105**.

In decision block **315** when one or more candidate images **40** are aligned with the enrollment image **20**, authentication/non-authentication may be performed. Authentication of the candidate person may be verified as the previously enrolled person by comparing the enrollment image **20** with the authentication image. Authentication is verified by
10 associating (step **317**) the candidate image as an authentication image of the candidate person.

In decision block **315** when the time series of candidate images **40** are not fully aligned with the enrollment image **20** on display **109**, alignment by the candidate person the candidate images **40** with the enrollment image **20** continues in step **513**.

15 Reference is now made to Figure 6 which shows a method **801**, according to a feature of the present invention. In step **807** a previously stored enrollment image is shown to a person for enrollment purposes. Reference is now also made to Figures 7 and 8 which show examples of previously stored enrollment images **65** and **75** respectively on display
20 **109**. Enrollment image **65** is an ellipse in which the person aligns the image of his/her hand **33** within ellipse **65**. A dotted line **37** is shown going through ellipse **65** may be used to align the image of the middle finger and wrist. Image **75** includes dashed lines to which the person aligns respective images of his/her wrist and fingers of hand **33**.

Referring back to Figure 6, in step **809**, the person is instructed to present a body part, *e.g.* hand **33** to camera **105**. In step **809**, candidate image **40** of the person is captured
25 while the person attempts an alignment of candidate image **40** with the previously stored enrollment image displayed on display **109**. With respect to image **65** and step **809**, the person aligns images of each finger tip just within perimeter of ellipse **65** and the middle finger are aligned symmetrically around dotted line **37** going through ellipse **65**. With respect to image **75** and step **809**, the person tries to ensure that each finger of his/ her

hand **33** is centered and in parallel with dotted lines of image **75**. In decision **815**, once the alignment in step **809** is achieved, verification is performed by verifying (step **317**) candidate image **40** as an authentic image of the person. Otherwise alignment by the person continues with step **809**.

5 When previously stored enrollment images **65/75** are used, the enrolling person may select one or more previously stored enrollment images **65/75** from a bank of for instance ten to one hundred stored images stored in memory **102** of mobile computer system **100**, for instance with which to perform enrollment capture step **503**. The selection of the previously stored enrollment image **65/75** provides for additional security and allows for
10 the person to select an enrollment image **65/75** suitable to her hand **33** in this example.

Reference is made to Figures 9 and 10 which show a method **901** and an enrollment image **95** shown on display **109** respectively, according to a feature of the present invention. In step **903**, enrollment image **95** of a body part of a person is captured with camera **105**. The body part as shown in enrollment image **95** (Figure 10a) is the hand of the person.
15 Enrollment image **95** as captured in step **903** is then presented to the person on display **109** (step **905**). On the enrollment image, the person is able to superimpose (step **907**) symbols **101**, e.g rectangle over features of the body part as presented on display **109**.

Alternatively in step **907**, the person is given the option via a menu on display **109** to hand-write and position their own symbols to be superimposed over features of the body
20 part as presented on display **109**. The handwriting of the person's own symbols to appear on display **109** is via a mouse, stylus operatively connected to computer system **100** or by finger touch of the person on display **109**. The person's own symbols for example may be the selection of a free hand curve from the menu so that a contour of a chin or a hair line may be drawn.

25 Features of the hand as shown in Figure 10a may include ridges, lines, wrinkles, scars or the curved portion connecting fingers. Superimposition (step **907**) may include the person relocating, resizing and / or rotating the symbols over the features.

In decision **909**, upon successfully superimposing symbols **101** on display **109** with features of the hand. The symbols **101** are stored along with respective positions,

orientations, features of the hand and/ or symbols **101** in image space as the enrollment image **95** (step **911**). If the symbols **101** on display **109** are not yet superimposed with features of the hand, superimposing continues with step **907**.

Referring back to Figure 9, authentication of a candidate person now continues with steps **913-921**. In step **913**, the enrollment image **95** stored in step **911** is presented on display **109**. Mobile computer system **100** in step **913**, instructs the candidate person to present a candidate body part to a camera. With the candidate body part being a hand for example, a time series of candidate images are captured of the hand with camera **105**. During capturing step **913**, the time series of candidate images are superimposed (step **915**) with enrollment image **95** and displayed on display **109**. In step **917**, at least one of the candidate images may be aligned with enrollment image **95** so that corresponding features in enrollment image **95** and one or more of candidate images are aligned. In aligning (step **917**), the candidate may move her hand in front of camera **105** so that features, *e.g.* lines, wrinkles, etc used for identification known only by the enrolled person are aligned with symbols **101**.

Alternatively in step **913** the candidate person is shown on display **109** multiple enrollment images **95** randomly selected in a consecutive manner with an unknown combination and timing. Additionally in step **913** a sequence of enrollment images **95** or an enrolled video is shown on display **109**. The user's hand, for example, follows the enrollment video or the sequence of enrollment images **95** as displayed on display **109** optionally in an unpredictable apparently random manner. The enrollment video may change speed or even freeze on display **109**. The candidate person may follow and may superimpose his candidate body part, *e.g.* hand, with the sequence of enrollment images on display **109** in real time.

In decision **919**, upon a successful alignment of the correct features with the symbols then verification **317** may be performed based for instance on the teachings of US patent 7,327,858. Otherwise, upon unsuccessful alignment or denial of authentication, the candidate person may instructed again to present her hand again in front of camera **105** with step **913**.

Reference is now made to Figure 10b which illustrates another example of the use of symbols **101** shown as software pegs **101** on display **109**. Software pegs **101b** may be positioned by the person so that software pegs **101** locate the curved connection between fingers, for example.

Reference is made to Figure 11 which includes a flow diagram illustrating a method **1101**, according to a feature of the present invention. In step **1103**, a person is presented with multiple previously defined enrollment scales on display **109**. Examples of previously defined enrollment scales shown on display **109** are shown in Figure 12 as scales or
5 graticules **1201a-1201c** which have respective graticule lines **1203a-1203c**.

Referring back to method **1101**, Figure 11 in step **1105**, enrollment images of a body part of the person are captured with camera **105**. In step **1107**, enrollment image of the person is presented to the person on display **109**. The person is able to select (step **1109**) a graticule scale **1201a-1201c**, while enrollment images are superimposed with the selected
10 graticule or scale **1201-1201c**. Using graticule **1201b** as the selected scale, the person may reposition or rotate selected graticule scale **1201b** so that graticule line **1203b** is positioned on line **1205b** of the hand of the person as shown in Figure 14. Alternatively, the person rotates and positions their hand so that graticule line **1203b** is positioned on line **1205b** of the hand of the person as shown in Figure 15. Referring back to method
15 **1101**, Figure 11, in step **1111** an enrollment image **20** of the body part of the person is stored along with selected graticule scale **1201b** and associated with the enrolled person.

Authentication steps **1113-1123** are the steps which verify that a candidate person is or is not the person previously enrolled in steps **1101-1111**. In step **1113**, identification (ID) number of a candidate person may be received by mobile computer system **100**.

20 The candidate person is instructed by system **100** to present a candidate body part to camera **105** so as to capture candidate images **40** of the candidate body part (step **1115**).

The captured candidate images are presented (step **1117**) superimposed on the selected enrollment scale. **1201**. In step **1119**, the candidate aligns one of the candidate images with selected enrollment scale **1201**. In decision block **1121**, if there is an alignment
25 between candidate image **40** and selected scale **1201**, then candidate image **40** may be

verified or not verified as an authentic image of the candidate person as the previously enrolled person in step **1123**. Otherwise in decision **1121** alignment by the candidate person may continue in step **1119** or after number of failed alignments, the candidate person is notified that an authentication of them was unsuccessful.

- 5 Further security features are involved in steps **1115** and **1117**. In order to verify (step **317**) candidate image **40** as an authentic image, candidate body part and features need to be identical to the body part and features used during enrollment. Moreover, selected scale **1201** has to be selected by the candidate person as that used during enrollment, to achieve verification that the candidate image is authentic.
- 10 During the enrollment processes shown above in Figures 13, 14 and 15, there may be no knowledge by mobile computer system **100** of the hand details (size etc) of a person to be enrolled. Therefore, in the enrollment stage, several graticule scales **1201** which have respective graticule lines **1203** may be displayed on display **109** and the person aligns their hand to each scale **1201**. Hands can be aligned to scales **1201** where the whole hand
15 should be placed inside a rectangular box of scale **1201**.

Referring to Figure 13, when the person aligns their hand on display **109** to each of the scales **1201** during enrollment, as a result, the hand may be actually placed at different distances to camera **105** for each of the scales **1201**. Mobile computer system **100** may select the best scale **1201** for the user where the features extracted from enrollment image
20 **20** related to corresponding scale **1201**, are the most robust and distinct. From this point on the best selected scale **1201** may be used for the person and an enrollment image saved and used during verification.

Regarding the one of many verification process described above. The same enrollment mechanism may be used by any one of the verification process described above and a
25 candidate person will have to select the required scale **1201** and place their hand according to their choice of hand placement. In the event of one too many attempted verifications of the candidate person, the candidate person may alternatively align their hand exactly as in the enrollment phase without presenting any information regarding their identity. The number of attempted verifications of the candidate person may now be

limited only to related enrollees in the same scale and rotation and the user may be identified.

Using graticule **1201b** as the selected scale, the person may reposition or rotate selected graticule scale **1201b** so that graticule line **1203b** is positioned on line **1205b** of the hand of the person as shown in Figure 14. Alternatively, the person rotates and positions their hand so that graticule line **1203b** is positioned on line **1205b** of the hand of the person as shown in Figure 15. The alternatives presented by figures 14 and 15 may apply to both the enrollment and verification processes or just to the enrollment process. In the verification process the scales **1201** may be predefined and unchangeable on display **109**.

10 The process of verification may be repeated in a specific way. For example, during enrollment the user selects one of scales **1201a**, **1201b**, **1201c** and aligns her hand to scale **1201**. If verification is successful, the user continues to a second verification step with a different scale and so on. For a more secure option, the user during enrollment may combine scales **1201** in sequential verification steps and hence create a password from the

15 ordered sequence of scales **1201**. For example if there are 9 squares of the same size arranged like the iPhone^{RTM} password screen. During verification the user may present the lines of one finger inside a specific square and then the lines of another finger at in a different specific square and so on. The combination of steps are saved in the enrollment phase and at each verification the user follows the same verification steps. Hence an

20 imposter cannot predict the combination of finger placements and selections of squares in the order performed during enrollment.

The embodiments of the present invention may comprise a general-purpose or special-purpose computer system including various computer hardware components, which are discussed in greater detail below. Embodiments within the scope of the present invention

25 also include computer-readable media for carrying or having computer-executable instructions, computer-readable instructions, or data structures stored thereon. Such computer-readable media may be any available media, which is accessible by a general-purpose or special-purpose computer system. By way of example, and not limitation, such computer-readable media can comprise non-transitory physical storage media such as

30 RAM, ROM, EPROM, flash disk, CD-ROM or other optical disk storage, magnetic disk

storage or other magnetic storage devices, or any other media which can be used to carry or store desired program code means in the form of computer-executable instructions, computer-readable instructions, or data structures and which may be accessed by a general-purpose or special-purpose computer system.

5 In this description and in the following claims, a " computer system" is defined as one or more software modules, one or more hardware modules, or combinations thereof, which work together to perform operations on electronic data. For example, the definition of computer system includes the hardware components of a personal computer, as well as software modules, such as the operating system of the personal computer. The physical
10 layout of the modules is not important. A computer system may include one or more computers coupled via a computer network. Likewise, a computer system may include a single physical device (such as a phone or Personal Digital Assistant "PDA") where internal modules (such as a memory and processor) work together to perform operations on electronic data. While any computer system may be mobile, the term "mobile computer
15 system" especially includes laptop computers, notebook computers, cellular telephones, smart phones, wireless telephones, personal digital assistants, portable computers with touch sensitive screens and the like.

In this description and in the following claims, a "network" is defined as any architecture where two or more computer systems may exchange data. The term "network" may
20 include wide area network, Internet local area network, Intranet, wireless networks such as "Wi-fi™", virtual private networks, mobile access network using access point name (APN) and Internet. Exchanged data may be in the form of electrical signals that are meaningful to the two or more computer systems. When data is transferred or provided over a network or another communications connection (either hardwired, wireless, or a
25 combination of hardwired or wireless) to a computer system or computer device, the connection is properly viewed as a transitory computer-readable medium. Thus, any such connection is properly termed a transitory computer-readable medium. Combinations of the above should also be included within the scope of transitory computer readable media and non-transitory computer-readable media. Computer-executable instructions comprise,
30 for example, instructions and data which cause a general-purpose computer system or special-purpose computer system to perform a certain function or group of functions.

The term "server" as used herein refers to a computer system including a processor, data storage and a network adapter generally configured to provide a service over the computer network. A computer system which receives a service provided by the server may be known as a "client" computer system.

Although selected embodiments of the present invention have been shown and described, it is to be understood the present invention is not limited to the described embodiments. Instead, it is to be appreciated that changes may be made to these embodiments without departing from the principles and spirit of the invention, the scope of which is defined by the claims and the equivalents thereof.

1. A computerized biometric method comprising: enrollment and authentication of a person.
 - wherein the authentication includes:
 - presenting on a display a previously stored enrollment image to the person;
 - instructing a candidate person to present a body part to a camera while the person is holding the body part unsupported in free space with respect to the camera. wherein said body part is of the candidate person:
 - using the camera. capturing a times series candidate image of the body part while enabling aligning by the candidate person said candidate image with said previously stored enrollment image:
 - upon said aligning. verifying said candidate image as an authentic image of said candidate person. thereby authenticating the candidate person as the person previously enrolled:
 - instructing the candidate person to align a feature of the body part in said candidate images with a corresponding feature in said enrollment image; and
 - upon the candidate person said aligning said feature of the body part in said candidate image with said corresponding feature in said enrollment image, said verifying at least one of said candidate images as an authentic image of said candidate person, thereby said authenticating the candidate person as the person previously enrolled by comparing said feature with the corresponding feature.
2. The computerized method of claim 1, wherein said previously stored enrollment image is generated independently from the person and the same enrollment image is displayed for said enrolling a plurality of previously unenrolled persons.
3. The computerized biometric method of claim 1, further comprising:
 - prior to said authenticating, enrolling the person thereby selecting by the person said previously stored enrollment image from a plurality of previously stored enrollment images.
4. The computerized biometric method of claim 1, wherein said aligning includes spatial and angular alignment in image space and distance in real space between a hand and the display.

5. The computerized biometric method of claim 1, wherein said aligning is performed by instructing the candidate person to align a feature of the body part in said candidate images with a corresponding feature in said enrollment image.
6. The computerized biometric method of claim 1, further comprising:
performing said verifying by comparing said enrollment image with said authentication image.
7. The computerized biometric method of claim 1, wherein said aligning includes alignment in horizontal, vertical image coordinates, angular orientation in image space, and real space distance to camera.
8. The computerized biometric method of claim 1, further comprising:
prior to said presenting said previously stored enrollment image, processing said enrollment image by performing horizontal mirror inversion of said enrollment images.
9. The computerized biometric method of claim 1, further comprising:
capturing a pre-enrollment image of a body part, while the person is holding the body part unsupported in free space with respect to the camera, wherein said body part is of the person;
presenting said pre-enrollment image to the person on a display;
upon presenting said pre-enrollment image, enabling the person to superimpose symbols with imaged features of the body part as presented on said display;
upon superimposing said symbols on said display with imaged features of the body part, storing as an enrollment image said symbols and respective positions and orientations in image space in said pre-enrollment image;
wherein the authenticating includes:
presenting on the display to a candidate person said enrollment image.

10. The computerized biometric method of claim 9, further comprising: prior to said superimposing at least one of the steps of:

relocating said symbols;
resizing said symbols;
and rotating said
symbols.

11. The computerized biometric method of claim 9, wherein said presenting on said display to said candidate person said enrollment image includes presenting on said display said stored symbols and at least a portion of an image of said body part.

12. The computerized biometric method of claim 9, wherein said presenting on said display to said candidate person said enrollment image includes presenting said stored symbols without any portion of an image of said body part.

13. The computerized biometric method of claim 1, wherein the enrollment includes:

presenting on a display to the person, a plurality of previously defined enrollment scales;

enabling selecting at least one of the scales presented on said display to produce thereby a selected enrollment scale while enabling superimposing and repositioning of said at least one of said enrollment images with the selected scale;

storing said selected scale as at least one enrollment image;

wherein the authentication includes:

said presenting on a display said time series of said candidate images superimposed on said selected enrollment scale;

enabling aligning by said candidate person of at least one of said candidate images with said selected enrollment scale.

14. The computerized biometric method of claim 13, wherein during said authentication, said presenting said enrollment scale to the person includes said presenting a plurality of enrollment scales, the method further comprising:

selecting by the candidate person the selected enrollment scale.

20 01 20

15. A mobile computer system enabled to perform the computerized biometric method of claim 1, wherein the camera and the display are parts of the mobile computer system.

16. A non-transitory computer readable medium encoded with processing instructions for causing a processor to execute the method of claim 1.

20 01 20