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Information technology — Cross-jurisdictional and societal aspects of implementation of biometric technologies — Pictograms, icons and symbols for use with biometric systems —

Part 4: Fingerprint applications

Technologies de l'information — Aspects sociétaux et trans-juridictionnels de la mise en oeuvre des technologies biométriques — Pictogrammes, icônes et symboles pour utilisation avec les systèmes biométriques —

Partie 4: Applications des empreintes digitales

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/IEC JTC1, *Information technology*, Subcommittee SC 37, *Biometrics*.

A list of all parts in the ISO/IEC 24779 series can be found on the ISO website.

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Introduction

A major public application of biometric recognition today is likely to be passports, but in the near future, it is probable that biometric recognition will be used in other public devices. These devices will be located in a variety of environments including unsupervised, a device supervised by an attendant or only partly supervised — for example, an attendant supervising a number of devices or devices observed via CCTV and an audio link. Language-independent pictograms, icons and symbols that indicate the biometric modality and illustrate actions and behaviour required will be particularly important for occasional users. In general, it is desirable for there to be more than one mode of presentation (e.g. visual and audible or tactile). Only visual presentation is addressed in ISO/IEC 24779.

It is recommended that pictograms, icons and symbols are used in the enrolment process, so that the subject becomes familiar with their meaning.

A standard family of pictograms, icons and symbols is required since in the absence of widely used standard pictograms, icons and symbols, manufacturers will adopt their own proprietary printed pictograms, icons and symbols for display on screens. This is likely to lead to confusion for public users of self-service devices.

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Information technology — Cross-jurisdictional and societal aspects of implementation of biometric technologies — Pictograms, icons and symbols for use with biometric systems —

Part 4: Fingerprint applications

1 Scope

This document contains a set of symbols, icons and pictograms to help the general public understand the concepts and procedures for using electronic systems that collect and/or process fingerprints. This set of symbols, icons and pictograms is designed to be used to

— identify the type of biometric device,

— provide static instructions related to a fingerprint device,

— display dynamic real-time information related to the fingerprint device, and

— indicate the status of the fingerprint device.

To provide this functionality, the set of symbols, icons and pictograms includes both directional symbols, icons and pictograms and real-time action or feedback symbols, icons and pictograms. The fingerprint device symbols, icons and pictograms can be categorized as

— finger/hand general biometric,

  — kind of finger, four fingers or hand device,

— finger/hand placement,

  — biometric position and impression which needs to be presented next,

  — hand orientation (switched hands),

— finger/hand quality feedback,

  — press (more or less),

  — raise/lower angle,

— finger/hand positioning,

  — hand/finger orientation,

  — necessary finger/hand movement (forward, backward, lateral),

  — rotation,

  — change angle, and

  — rolling finger(s).

Although the symbols, icons and pictograms are presented individually, it is intended that the symbols, icons and pictograms be combined to fully illustrate the fingerprinting interaction.

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Alternative illustrations might be used; for example, in a customs or immigration environment, procedures constructed from the individual symbols, icons and pictograms could additionally be presented as

— a series of posters while waiting to use the biometric system,

— a series of transitional frames in a biometric booth,

— an animated video or series of transitional frames while waiting to use the biometric system, and

— instructional leaflets to read while waiting to use the biometric system.

This multi-part International standard focuses on communication with the data capture subject. Operators could use this International standard, but they might need additional symbols and information.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Individual symbols, icons and pictograms

4.1 General

The symbols and icons for aiding the fingerprint presentations are shown in the following figures.

The symbols, icons and pictograms included in this clause have undergone usability testing[1)]. The symbols, icons and pictograms were tested with representative users using two different methods. The first round of testing used interviews. Using this approach, the interviewers described the context in which the symbols, icons and pictograms were to be used and asked each participant to identify the meaning of each symbol, icon or pictogram. This testing was followed by operational testing or task-based testing where participants were asked to take actions and interact with fingerprint devices based on the symbols, icons or pictograms. A more detailed description of the testing procedures and results are presented in Annex A.

4.2 General symbol indicating fingerprint application

The following symbol should be used to indicate that a fingerprint application is in place.

1) Research conducted by the National Institute of Standards and Technology (NIST).

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Figure 1 — Fingerprint application [IEC 60417-6338]

On biometric systems, this symbol is used to indicate that the system is dedicated to fingerprint applications.

There should also be an indication of the finger(s) to be used.

4.3 Finger/hand placement

The platen and fingers are visualized at equal value or identical line width to better convey pressing and touching, and to prevent hovering. Fingernails are included to reinforce hand orientation and prevent "hovering" over the platen. In the full procedure, these symbols, icons and pictograms should be accompanied by a consistent profile image (see Figures 7, 8 and 9) to reinforce pressing and not hovering.

Symbols, icons and pictograms visualizing other fingers than those shown above can be drawn equivalently.

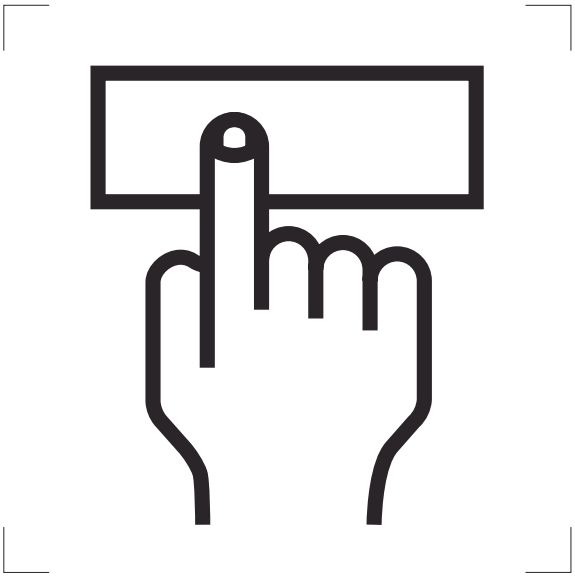

Figure 2 — Finger/hand placement, index finger of right hand [IEC 60417-6339-1]

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On biometric systems, this symbol is used to indicate that the system requests the index finger of the right hand to be placed on the platen.

A mirrored graphical symbol may be used to indicate that the system requests the index finger of the left hand to be placed on the platen.

NOTE 1 The meaning of this graphical symbol depends on its orientation.

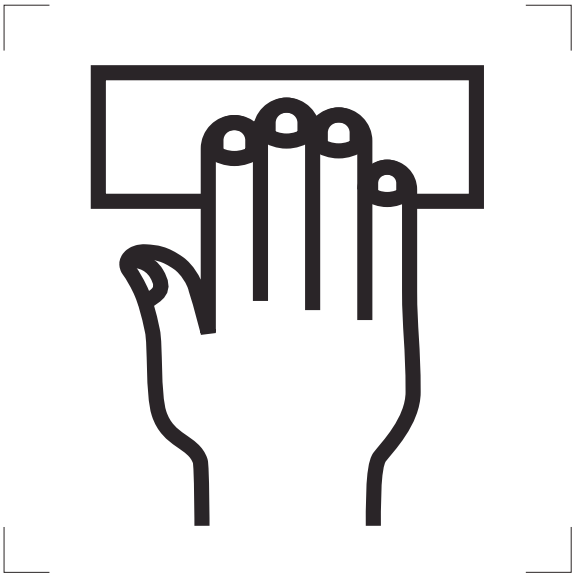

Figure 3 — Finger/hand placement, four fingers of right hand [IEC 60417-6339-2]

On biometric systems, this symbol is used to indicate that the system requests the four fingers of the right hand to be placed on the platen.

A mirrored graphical symbol may be used to indicate that the system requests the four fingers of the left hand to be placed on the platen.

NOTE 2 The meaning of this graphical symbol depends on its orientation.

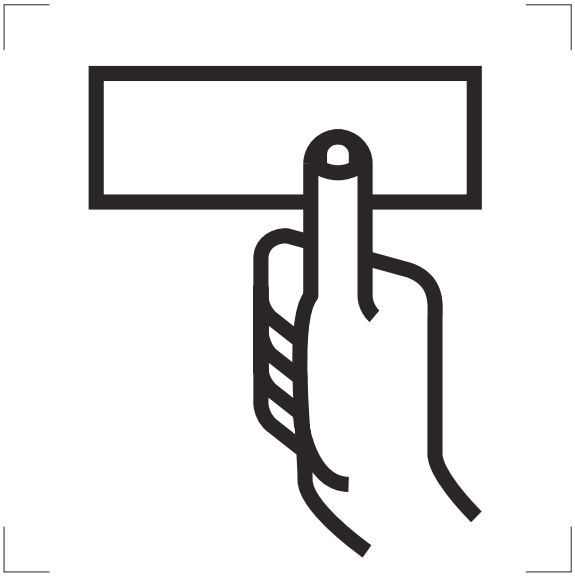

Figure 4 — Finger/hand placement, thumb of right hand [IEC 60417-6339-3]

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On biometric systems, this symbol is used to indicate that the system requests the thumb of the right hand to be placed on the platen.

A mirrored graphical symbol may be used to indicate that the system requests the thumb of the left hand to be placed on the platen.

NOTE 3 The meaning of this graphical symbol depends on its orientation.

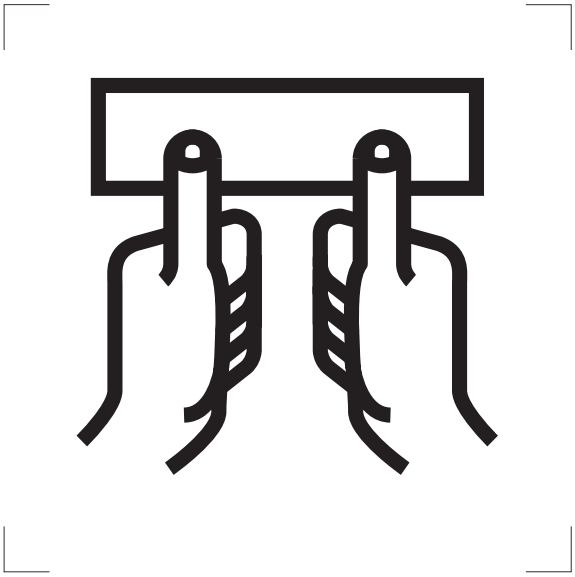

Figure 5 — Finger/hand placement, thumbs of left and right hands [IEC 60417-6340-1]

On biometric systems, this symbol is used to indicate that the system requests the thumbs of the left and right hands to be placed together on the platen.

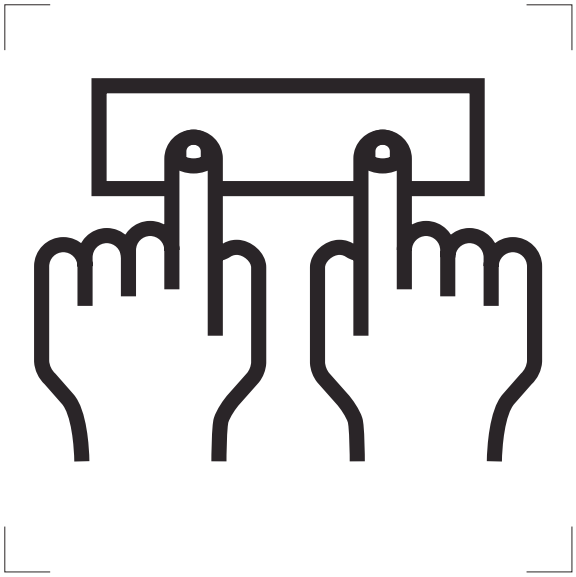

Figure 6 — Finger/hand placement, index fingers of left and right hands [IEC 60417-6340-2]

On biometric systems, this symbol is used to indicate that the system requests the index fingers of the left and right hands to be placed together on the platen.

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4.4 Finger/hand quality feedback

4.4.1 Press (more or less)

To reinforce pressing and not hovering, each main fingerprinting symbol should be accompanied by a consistent "press" image. In the complete procedure, this has been visualized as a profile of a generalized finger or thumb, either at a downward angle, or side angle (to reflect the general orientation of the device). For a dynamic "Press more/less" indicator on the device itself, a simple + or – sign can suffice, as the device can provide more context about what is "more" or "less" required.

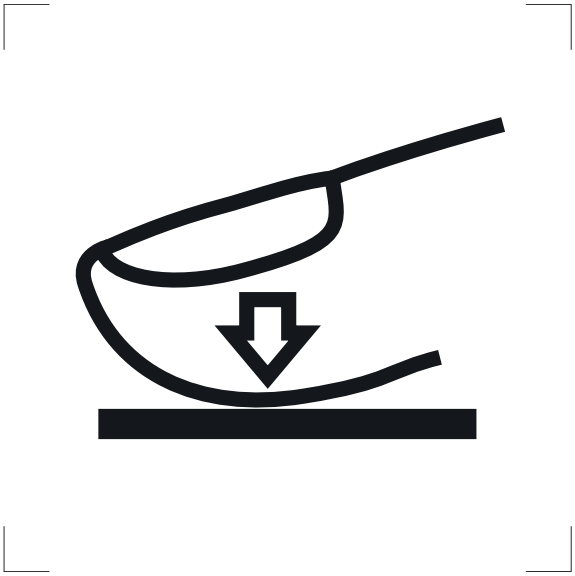

Figure 7 — Press [IEC 60417-6341]

On biometric systems, this symbol is used to indicate that the system requests the finger should be placed on the platen.

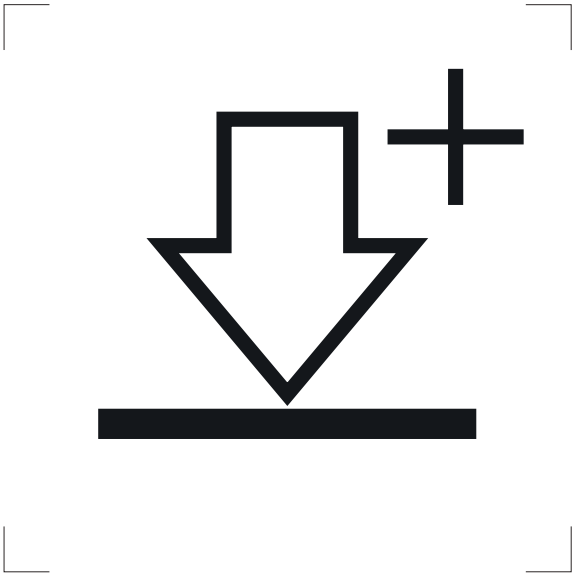

Figure 8 — Increase pressure [IEC 60417-6342-1]

On biometric systems, this symbol is used to indicate that the system requests the finger/hand should be placed on the platen with increased pressure.

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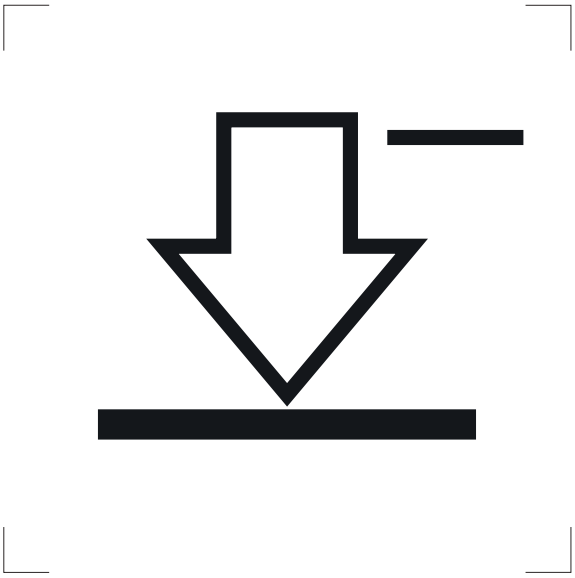

Figure 9 — Decrease pressure [IEC 60417-6342-2]

On biometric systems, this symbol is used to indicate that the system requests the finger/hand should be placed on the platen with decreased pressure.

4.4.2 Raise/lower angle

The following symbols should be used in order to indicate that the subject needs to raise or to lower the angle of the finger(s).

Figure 10 — Raise angle [IEC 60417-6344-1]

On biometric systems, this symbol is used to indicate that the subject needs to raise the angle of the finger(s).

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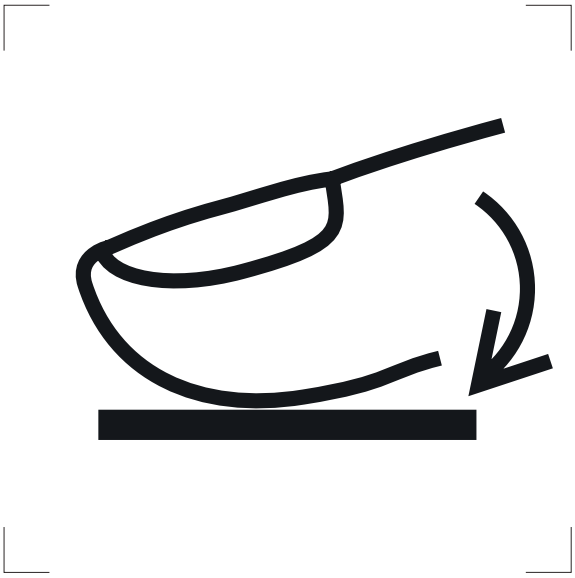

Figure 11 — Lower angle [IEC 60417-6344-2]

On biometric systems, this symbol is used to indicate that the subject needs to lower the angle of the finger(s).

5 Finger/hand positioning

5.1 General

The following figures in Clause 5 provide real-time guidance to the biometric subjects on how to adjust and correct their hand positioning from an undesirable position. This visual guidance is only to be used in an interactive environment, i.e. the fingerprint scanning system is capable of detecting the erroneous conditions of a subject's hand positioning and providing immediate feedback in a visual form. This visual guidance is not suitable for cases where information is only communicative and not operational, such as posters, hand-outs or procedural instructions. Thus, it is logical to interactively display this visual guidance, called for by erroneous situations, on an electronic monitor that can show the current system status of the scanning process and the corresponding visual guidance.

This visual guidance is only applicable under the following conditions:

— a fingerprint scanning process is in progress;

— the system is capable of detecting whether or not the subject's hand positioning is within acceptable criteria and capable of providing real-time and interactive feedback on the scanning status.

Indicators other than this visual guidance may be used to provide feedback to the subject (e.g. for completion of an action).

In Clause 5, the dotted figures of four fingers or thumb are examples of indicators given by biometric products. In real uses, the shape of the figure should be similar, but might be changed.

The small darker corner images are intended as distinctive, bullet-like reminders that would sit in contrast to any potential visual guidance that might appear in the platen display. The small icons serve as reminders (to the biometric subjects) of the desired print image being captured. Icons are small in nature and need to be simplistic to communicate its intended meaning without cluttering the display where other information (e.g. the fingerprint image, the positioning guidance, etc.) is present and is competing for users' attention. The symbols designated for finger placement in 4.3 can be adapted and used as small icons. However, symbols used as icons do have a potential for confusion as the intention

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of their use is different. A symbol is asking for action of the subject, whereas a small icon is giving information and an indication of context.

5.2 Overlay visual guidance for finger/hand orientation

The overlay visual guidance provides a general guidance for the biometric subjects on where to place their hands and thumbs on the system's scanning platen. The following figures (Figures 12 to 15) show examples of how the overlays with associated icons are presented in proportion to a scanning platen.

If the display of a preview with overlay is not supported by the used sensor, a similar animation shall be used to provide similar dynamic user guidance. The small darker corner images shall be present as defined for the preview with overlay.

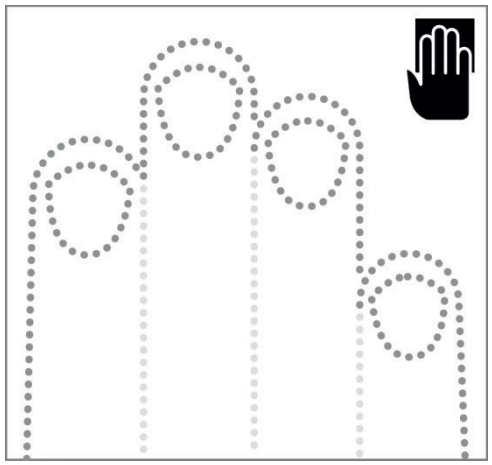

Figure 12 — Overlay (right four fingers)

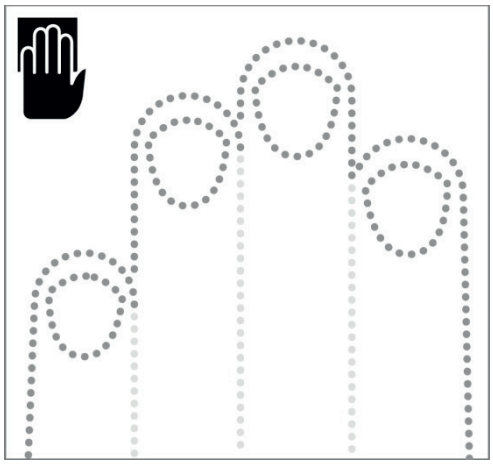

Figure 13 — Overlay (left four fingers)

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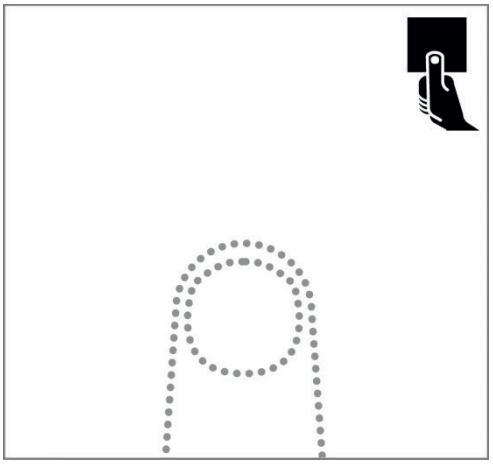

Figure 14 — Overlay (right thumb)

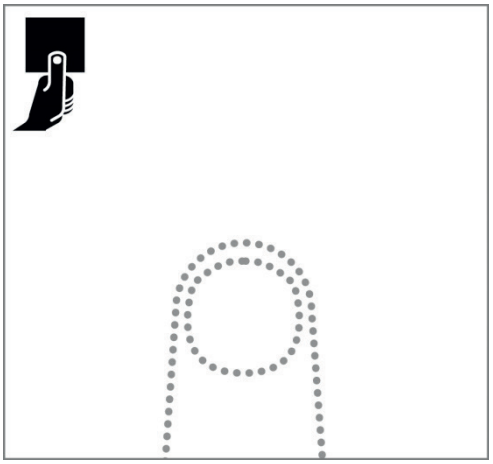

Figure 15 — Overlay (left thumb)

During the scanning process, the biometric subject would follow each overlay visual guidance and place his/her hand on the platen accordingly, and the system should display a live video (e.g. on a monitor) of the subject's fingerprint and any necessary corrective visual guidance depending on the subject's hand positioning, before capturing the fingerprint. Figure 16 shows an example of a live video capture with a subject's right four fingers.

NOTE The fingerprint was intentionally blurred to protect the privacy of the test subject.

In this example, a corrective visual guidance of "Move left" will be needed.

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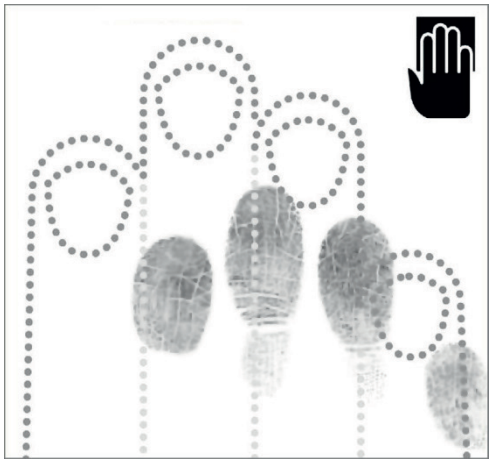

Figure 16 — Example of a right four fingers requiring "Move left" adjustment

5.3 Necessary finger/hand movement

5.3.1 Lateral movements

5.3.1.1 General

When the fingerprint scanning system detects that the subjects' hands/thumbs are either off to the right or left, the system will display corrective visual guidance to guide subjects on adjusting their hand positioning laterally. It should be noted that the visual guidance cannot tell the subjects how much lateral movement is needed. However, through interactive position detections and feedback from the system, the subjects will be able to assume desirable hand positions after few corrective movements.

5.3.1.2 Move right

The following figures (Figures 17 to 20) show corrective visual guidance to guide subjects to move their hands/thumbs to the right. There are three components in each visual representation: (1) the overlay; (2) a small icon indicating which hand (e.g. right or left hand) and print (e.g. four fingers or thumb) are being scanned, with a small arrow showing the desirable moving direction; and (3) a big arrow also indicating the desirable moving direction. It is recommended that the third component, i.e. the big arrow, be implemented with some animation (e.g. slight horizontal movement from left to right) to reinforce the desirable corrective direction.

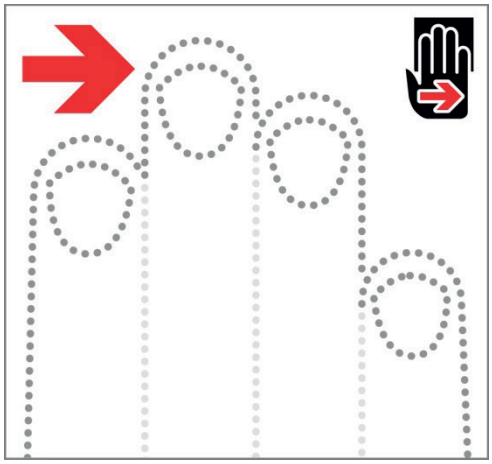

Figure 17 — Move right (right four fingers)

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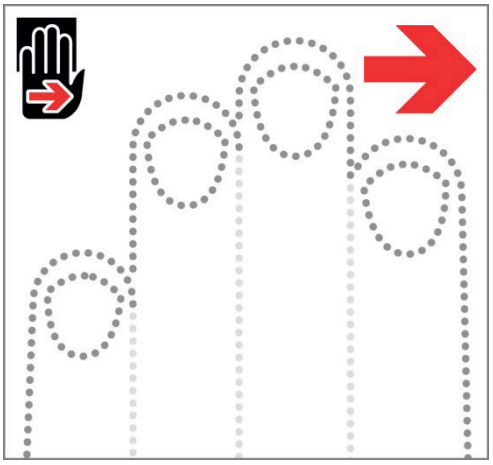

Figure 18 — Move right (left four fingers)

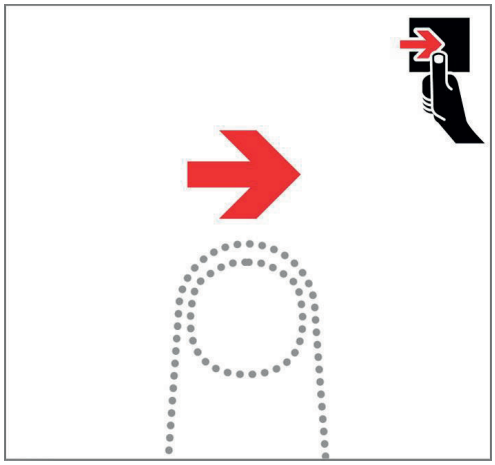

Figure 19 — Move right (right thumb)

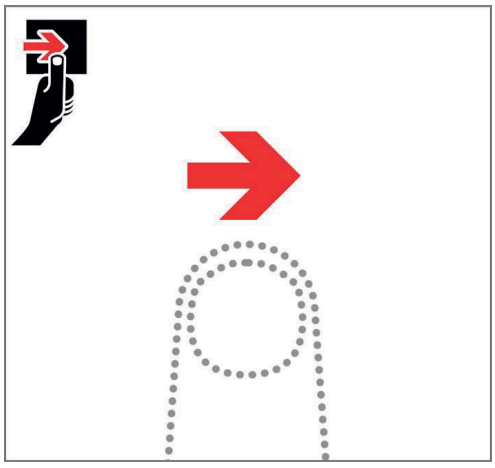

Figure 20 — Move right (left thumb)

5.3.1.3 Move left

The following figures (Figures 21 to 24) show corrective visual guidance to guide subjects to move their hands/thumbs to the left. There are three components in each visual representation: (1) the

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overlay; (2) a small icon indicating which hand (e.g. right or left hand) and print (e.g. four fingers or thumb) are being scanned, with a small arrow showing the desirable moving direction; and (3) a big arrow also indicating the desirable moving direction. It is recommended that the third component, i.e. the big arrow, be implemented with some animation (e.g. slight horizontal movement from right to left) to reinforce the desirable corrective direction.

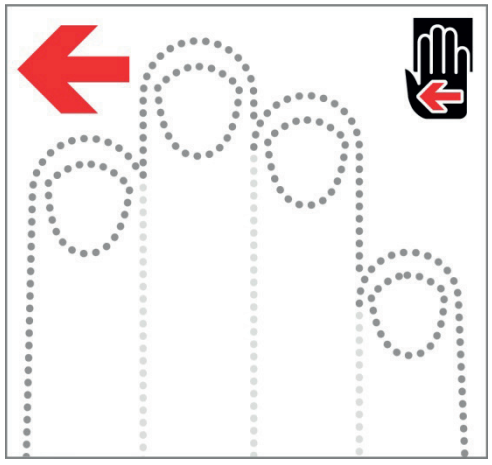

Figure 21 — Move left (right four fingers)

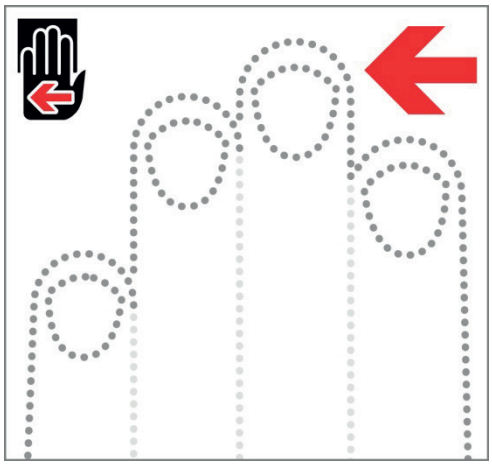

Figure 22 — Move left (left four fingers)

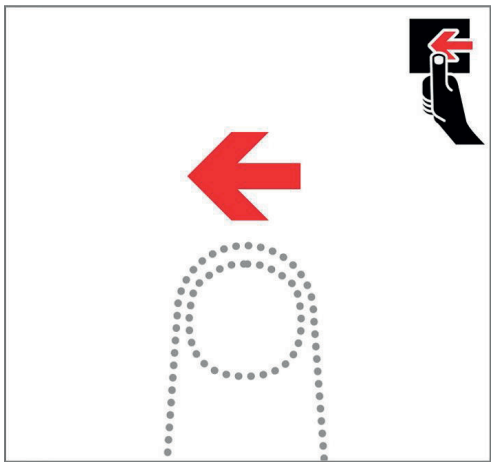

Figure 23 — Move left (right thumb)

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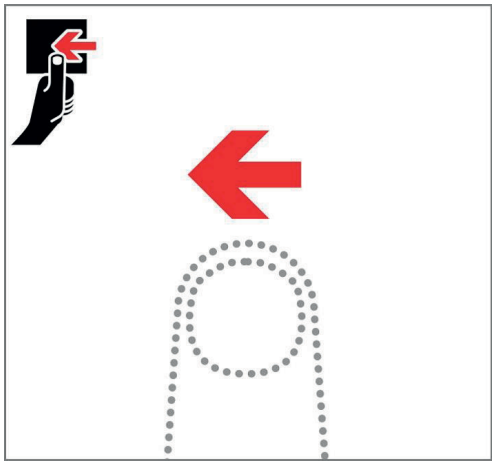

Figure 24 — Move left (left thumb)

5.3.2 Forward/backward movements

5.3.2.1 General

When the fingerprint scanning system detects that the subjects' hands/thumbs are either too close to the top or to the bottom of the scanning platen, the system will display these corrective visual guidance to guide subjects on adjusting their hand position. It should be noted that the visual guidance could not tell the subjects how much movement of forward or backward is needed. However, through interactive position detections and feedback from the system, the subjects will be able to assume desirable hand positions after few corrective movements.

EXAMPLE It is more understandable for the users to show visual instructions with animation. An example of stepwise illustrations of the animation of Figure 30 is given in Annex C.

5.3.2.2 Move forward

The following figures (Figures 25 to 28) show corrective visual guidance to guide subjects to move forward their hands/thumbs. There are three components in each visual representation: (1) the overlay; (2) a small icon indicating which hand (e.g. right or left hand) and print (e.g. four fingers or thumb) are being scanned, with a small arrow showing the desirable moving direction; (3) a big arrow also indicating the desirable moving direction. It is recommended that the third component, i.e. the big arrow, be implemented with some animation (e.g. slight forward movement) to reinforce the desirable corrective direction.

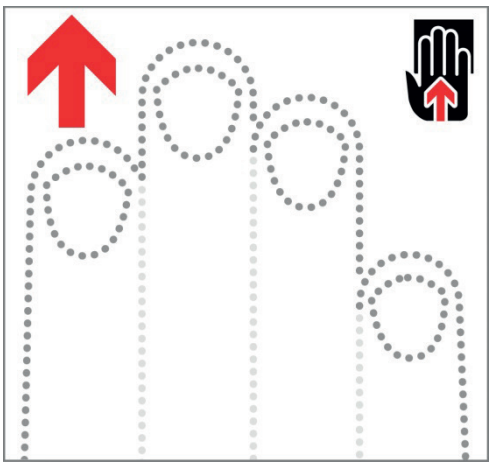

Figure 25 — Move forward (right four fingers)

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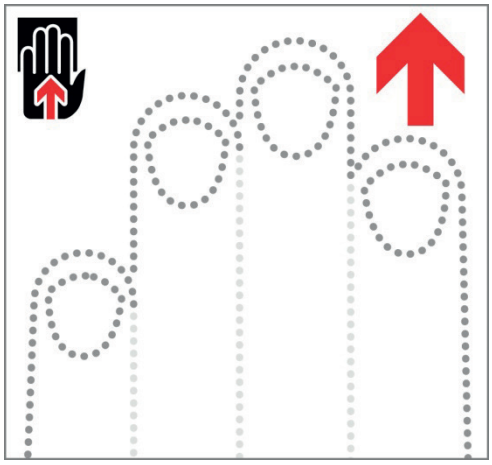

Figure 26 — Move forward (left four fingers)

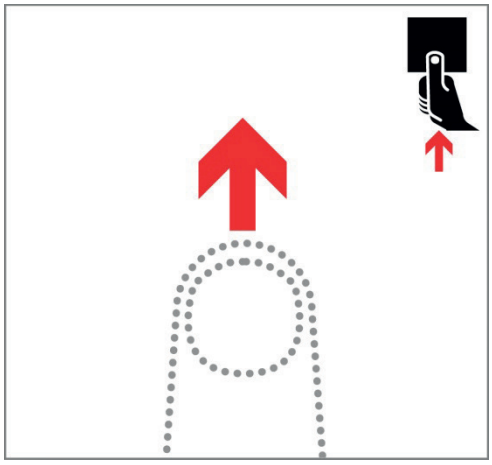

Figure 27 — Move forward (right thumb)

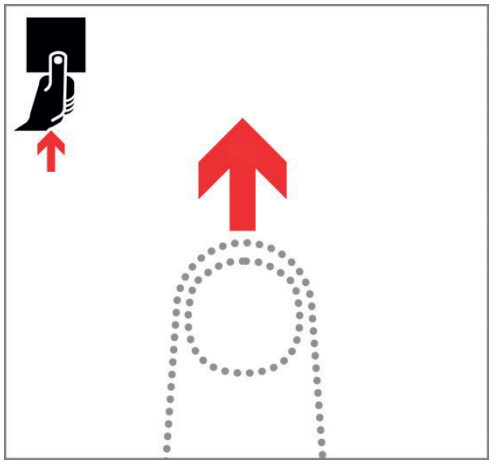

Figure 28 — Move forward (left thumb)

5.3.2.3 Move backward

The following figures (Figures 29 to 32) show corrective visual guidance to guide subjects to move their hands/thumbs backward. There are three components in each visual representation: (1) the

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overlay; (2) a small icon indicating which hand (e.g. right or left hand) and print (e.g. four fingers or thumb) are being scanned, with a small arrow showing the desirable moving direction; (3) a big arrow also indicating the desirable moving direction. It is recommended that the third component, i.e. the big arrow, be implemented with some animation (e.g. slight backward movement) to reinforce the desirable corrective direction.

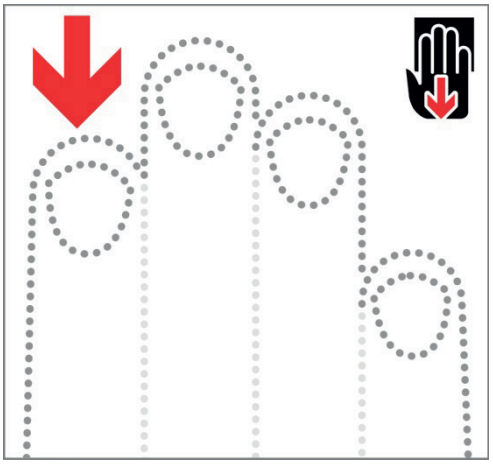

Figure 29 — Move backward (right four fingers)

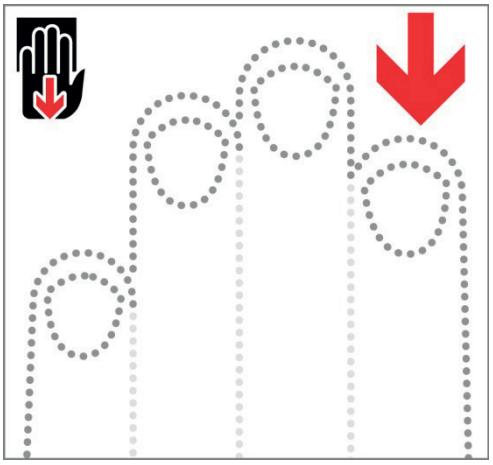

Figure 30 — Move backward (left four fingers)

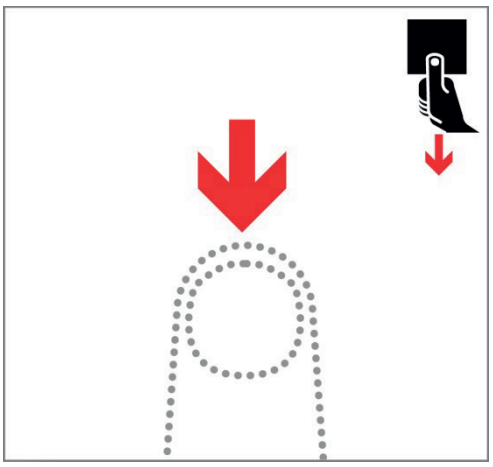

Figure 31 — Move backward (right thumb)

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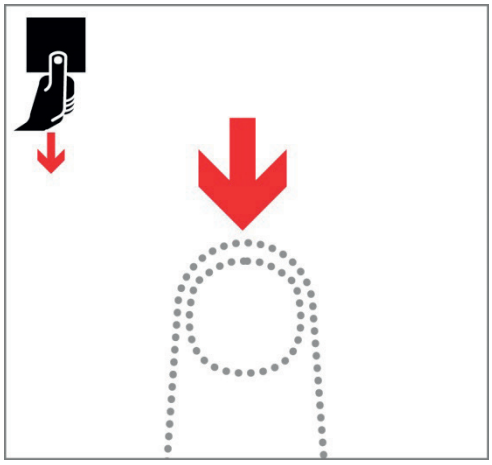

Figure 32 — Move backward (left thumb)

5.4 Rotation

5.4.1 General

When the fingerprint scanning system detects that the subjects' hands/thumbs are not upright, the system will display these corrective visual guidance to guide subjects on rotating their hands. It should be noted that the visual guidance could not tell the subjects how much rotation is needed. However, through interactive position detections and feedback from the system, the subjects will be able to assume desirable hand positions after few corrective movements.

5.4.2 Rotate clockwise

The following figures (Figures 33 to 36) show corrective visual guidance to guide subjects to rotate their hands/thumbs in a clockwise direction. There are three components in each visual representation: (1) the overlay; (2) a small icon indicating which hand (e.g. right or left hand) and print (e.g. four fingers or thumb) are being scanned, with a small arrow showing the desirable moving direction; (3) a big arrow also indicating the desirable moving direction. It is recommended that the third component, i.e. the big arrow, be implemented with some animation (e.g. slight clockwise rotating movement) to reinforce the desirable corrective direction.

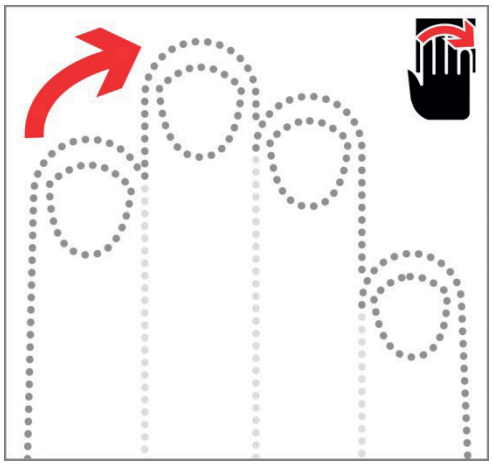

Figure 33 — Rotate clockwise (right four fingers)

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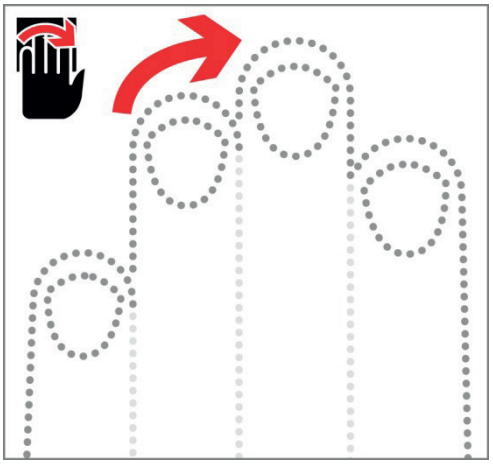

Figure 34 — Rotate clockwise (left four fingers)

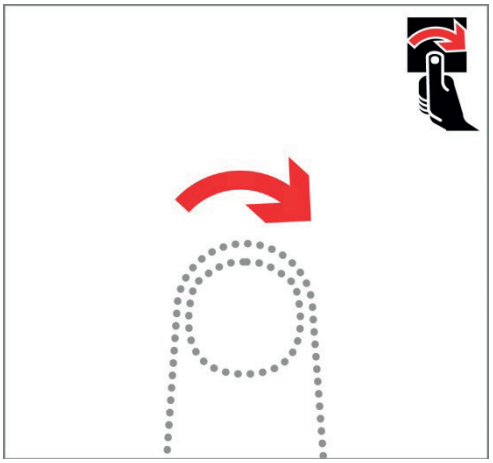

Figure 35 — Rotate clockwise (right thumb)

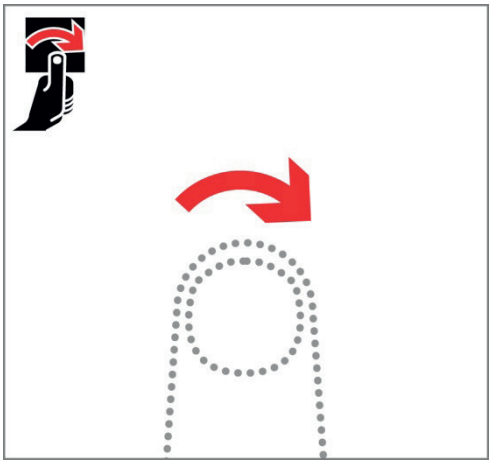

Figure 36 — Rotate clockwise (left thumb)

5.4.3 Rotate Counter-Clockwise

The following figures (Figures 37 to 40) show corrective visual guidance to guide subjects to rotate their hands/thumbs in a counter-clockwise direction. There are three components in each visual

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representation: (1) the overlay; (2) a small icon indicating which hand (e.g. right or left hand) and print (e.g. four fingers or thumb) are being scanned, with a small arrow showing the desirable moving direction; (3) a big arrow also indicating the desirable moving direction. It is recommended that the third component, i.e. the big arrow, be implemented with some animation (e.g. slight counter-clockwise rotating movement) to reinforce the desirable corrective direction.

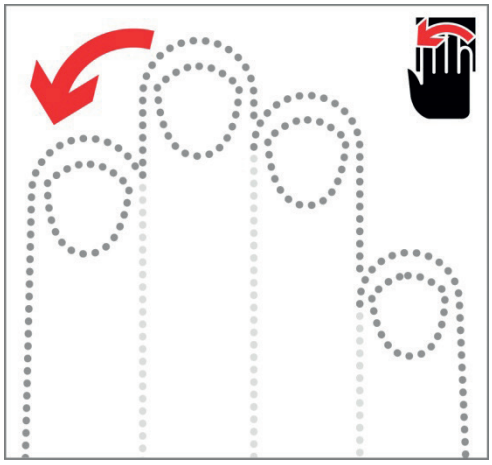

Figure 37 — Rotate counter-clockwise (right four fingers)

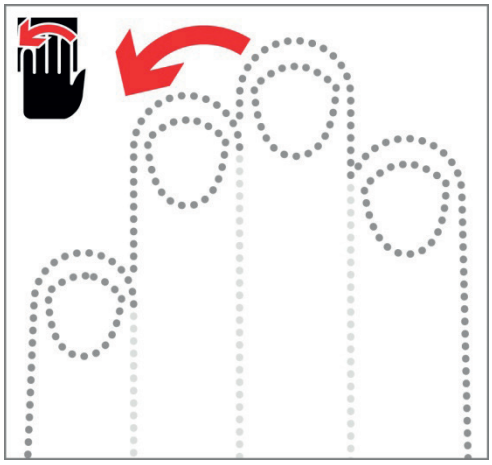

Figure 38 — Rotate counter-clockwise (left four fingers)

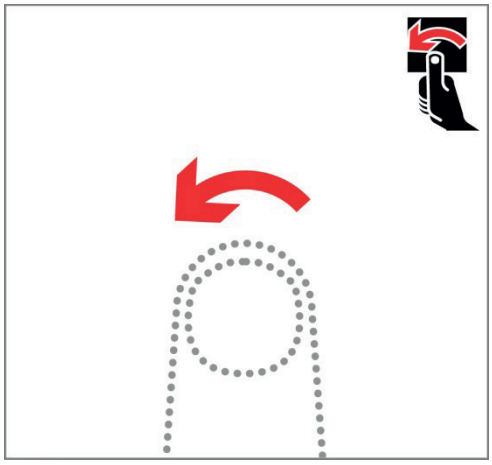

Figure 39 — Rotate counter-clockwise (right thumb)

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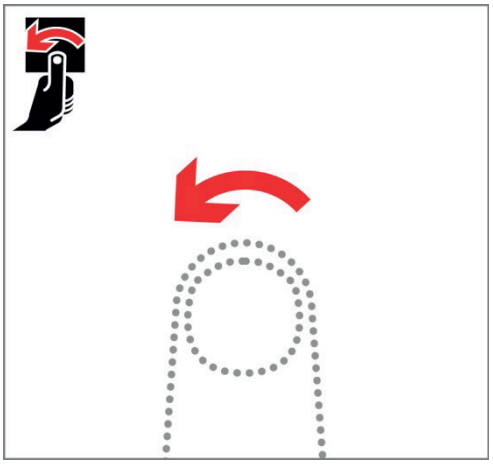

Figure 40 — Rotate counter-clockwise (left thumb)

5.5 Change angle

5.5.1 General

When the fingerprint scanning system detects that the tips of the subjects' hands/thumbs are either too close (i.e. angles too small) or too far (i.e. angle too big) from the scanning platen, the system will display these corrective visual guidance to guide subjects on adjusting the angles of their hands. It should be noted that the visual guidance could not tell the subjects how much movement is needed. However, through interactive position detections and feedback from the system, the subjects will be able to assume desirable hand positions after few corrective movements.

5.5.2 Raise/increase finger angles

The following figures (Figures 41 to 44) show corrective visual guidance to guide subjects to raise (or increase) the angles of their hands from the scanning platen. There are two components in each visual representation: (1) the overlay and (2) a finger with a small arrow showing the desirable moving direction. It is recommended that the arrow next to the gap between the finger and the horizontal line be implemented with some animation (e.g. slight upward movement) to reinforce the desirable corrective direction.

NOTE Note that with currently known fingerprinting technologies and requirements, this scenario is unlikely to happen.

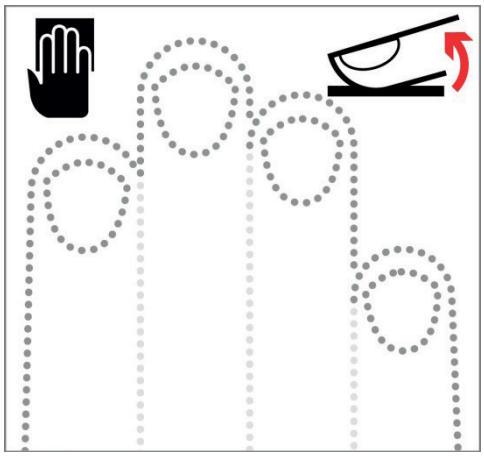

Figure 41 — Raise angle (right four fingers)

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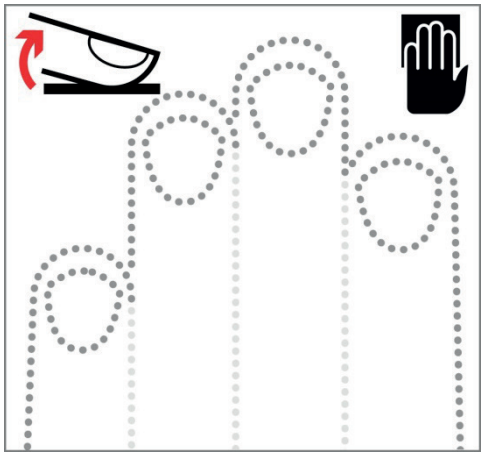

Figure 42 — Raise angle (left four fingers)

For thumb prints, note that a third component is needed (Figures 43 to 44), i.e. a small icon indicating which hand (right or left) is currently being scanned, as the overlay alone is not enough to communicate which side the target hand is.

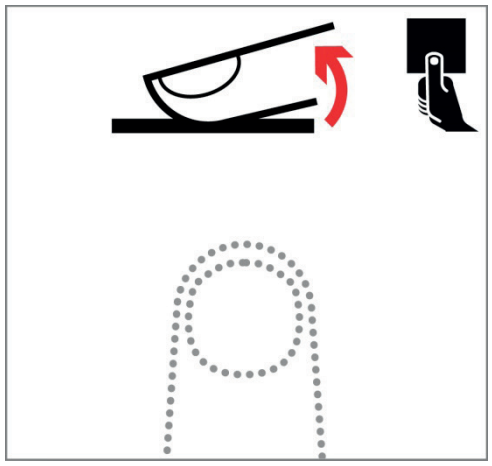

Figure 43 — Raise angle (right thumb)

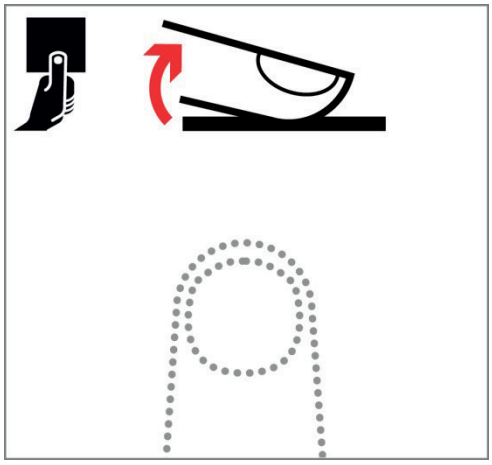

Figure 44 — Raise angle (left thumb)

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5.5.3 Lower/decrease finger angles

The following figures (Figures 45 to 48) show corrective visual guidance to guide subjects to lower (or decrease) the angles of their hands/thumbs to be closer to the scanning platen. There are two components in each visual representation: (1) the overlay and (2) a finger with a small arrow showing the desirable moving direction. It is recommended that the arrow next to the gap between the finger and the horizontal line be implemented with some animation (e.g. slight downward movement) to reinforce the desirable corrective direction.

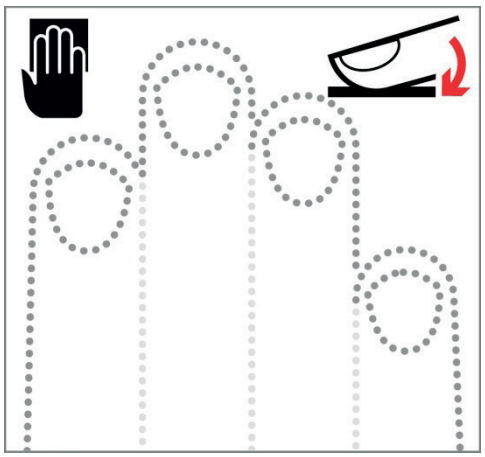

Figure 45 — Lower angle (right four fingers)

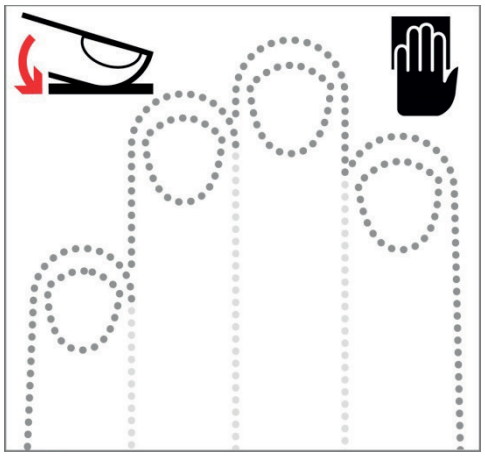

Figure 46 — Lower angle (left four fingers)

For thumb prints, note that a third component is needed (Figures 47 to 48), i.e. a small icon indicating which hand (right or left) is currently being scanned, as the overlay alone is not enough to communicate which side the target hand is.

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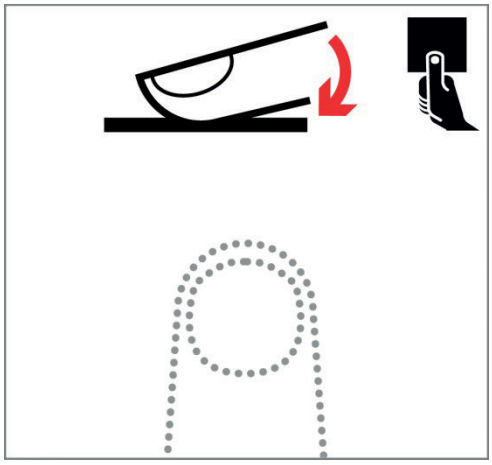

Figure 47 — Lower angle (right thumb)

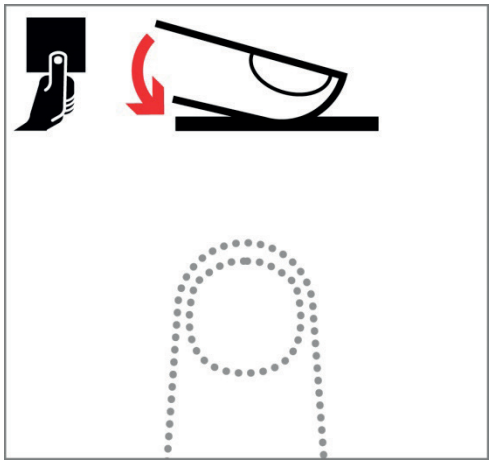

Figure 48 — Lower angle (left thumb)

5.6 Rolling finger(s)

During a rolls scanning process, the following visual guidance is provided on the direction of rolling fingers.

NOTE 1 Note that this clause is informative only, as rolling fingerprints is in general a supervised procedure.

NOTE 2 Note that this visual guidance is only to be used for single finger or thumb captures.

Acquisition can be done by rolling each finger either from left to right or from right to left.

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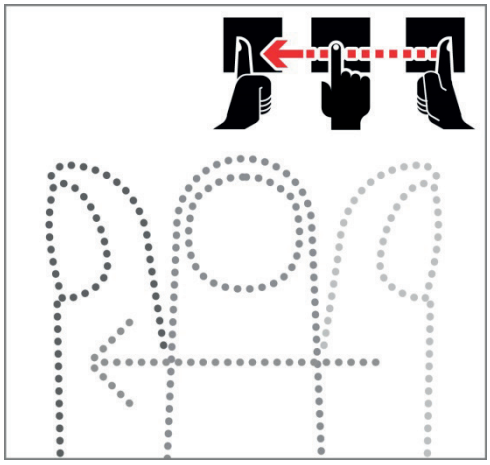

NOTE Hand depicted is an example.

Figure 49 — Roll finger — Right to left (right hand)

NOTE Hand depicted is an example.

Figure 50 — Roll finger — Left to right (left hand)

5.7 Testing of hand-positioning visual guidance

To ensure comprehensibility and usability, it is imperative to evaluate and test the visual guidance with target biometric subjects in the target locale(s) of application. It is only meaningful to perform the evaluation and testing in an operational configuration. An operational configuration will consist of the following components: a scanning system capable of detecting the erroneous conditions of a subject's hand positioning and providing immediate feedback in a visual form, a mechanism for displaying the real-time feedback (e.g. an LCD monitor) and target biometric subjects (not personnel involved in the development of the scanning system).

The visual guidance included in this clause has undergone usability testing[2)]. A description of the testing procedures and results are presented in Annex B.

2) Research conducted by the National Institute of Standards and Technology (NIST).

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Annex A
(informative)

Usability testing approach

A.1 General

The National Institute of Standards and Technology's (NIST) Biometrics Usability group designed a series of usability tests to investigate users' comprehension and understanding of the proposed symbols, icons and pictograms. The symbols, icons and pictograms were tested with representative users using two different methods. The first phase of testing used interviews. The second phase of testing was task based or operational testing where study participants used the symbols, icons and pictograms to interact with fingerprint scanners.

NOTE Some of the tested symbols are not only related to fingerprint applications but to biometric applications in general. These symbols therefore are included in ISO/IEC 24779-1. Specifically, this applies to the following symbols: Wait/Hold, Acceptable/unacceptable capture, Retry, Give up. The symbols "Ready State", "Start Capture" and "Exit" were considered being too generic for ISO/IEC 24779, as they are relevant to all information technology systems.

A.2 User interviews

A.2.1 Method

In phase one of the study, interviews to collect rich, detailed information about the symbols, icons and pictograms were used. The original set of symbols, icons and pictograms included eight categories of symbols, icons and pictograms:

— Ready State;

— Fingerprinting on the platen;

— Start Capture;

— Wait/Hold;

— Press more/less;

— Acceptable/unacceptable capture;

— Retry;

— Give up/exit.

NOTE Some descriptors of the individual symbols have changed in the standardization process.

Within each category, there were several alternatives for each symbol. The goal of the interviews was to identify which of the alternative symbols, icons and pictograms were most easily understood and which were more difficult to comprehend. This allowed the usability team to identify the most promising symbols, icons and pictograms and use the set of symbols, icons and pictograms requiring testing in phase two, the task-based usability testing.

A.2.2 Participants

Thirteen people participated in the study. All participants were NIST employees. Participants were specifically recruited with differing educational backgrounds and disciplines. Representative

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participants included scientists and engineers, administrative staff, cafeteria, photography and library staff members. None of the participants were working in the field of biometrics. All employees at NIST have been fingerprinted as a condition of employment. Three of the participants spoke English as their second language. Participants ranged in age from the mid-20s to early 60s.

A.2.3 Procedure

All of the interviews were conducted in the participant's office. The interviewer was accompanied by an observer whose primary role was to take notes documenting the participant's comments. The interviewer provided the participant with the background of the study, explaining that we were designing symbols, icons and pictograms to describe biometric processing such as fingerprinting and iris scanning in a multi-lingual environment. The interviewer also described the context of use of the symbols, icons and pictograms. For the first nine participants, they were asked to imagine that they are visiting another country and are approaching customs and immigration at the airport, these symbols, icons and pictograms might be displayed to describe the biometric process to them. The second set of four participants was given the same instructions except the interviewer placed a mock fingerprint scanner on the desk. Each of the symbols, icons and pictograms was printed on a separate sheet of paper. Each participant was asked the meaning of each symbol, icon or pictogram. Once the participant had viewed each individual symbol, icon or pictogram, then the procedure or process was presented. Again, the participant was asked to describe the meaning of the process.

A.2.4 Results

The results of the interviews are presented in Table A.1. Green indicates that the participant identified the meaning of the symbol correctly, yellow indicates that the meaning was somewhat understood, while pink indicates that the symbol was completely misunderstood. Participants who were presented with the mock fingerprint scanner were able to correctly identify more symbols, icons and pictograms, implying that strong context is critical for understanding the symbols, icons and pictograms.

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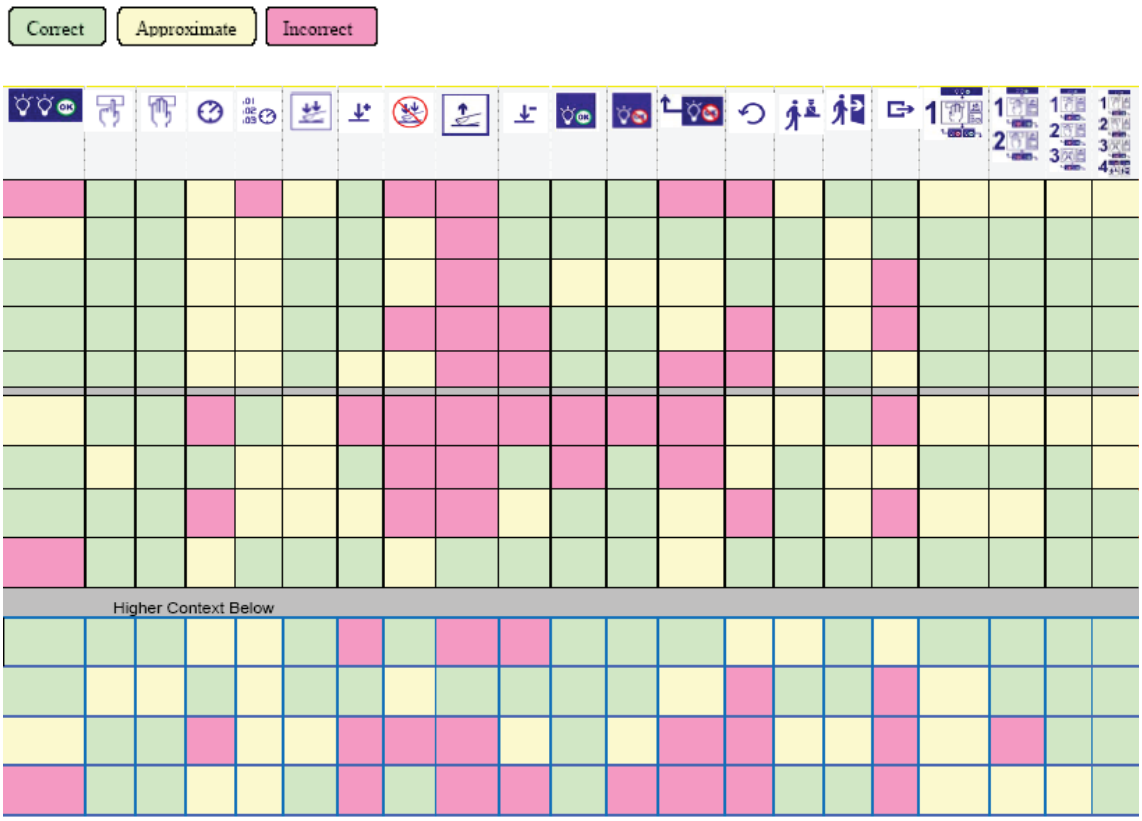
Table A.1 — Symbol interpretation



A.3 Task-based testing

From the user interviews, the number of alternatives for each symbol was used. Those symbols, icons and pictograms that were not well understood were eliminated from consideration and further testing. Those symbols, icons and pictograms that were fairly well understood were used in usability testing.

A.3.1 Method

A formative usability testing approach was used for phase two testing. This testing was task based, modelled after the operational environment. Participants were asked to follow the symbol procedures and interact with the mock fingerprint scanner. The talk-aloud protocol was also used. This protocol encourages the participants to talk while they are working on the task. Understanding what the participant is thinking as we observed him or her working on the tasks prevents observers from drawing false conclusions concerning the motivations for the actions.

A.3.2 Participants

Forty-four participants who spoke English as a second language were recruited from a Washington, D.C.-area database of study volunteers. The participants ranged from 25 to 70 years old in age. Approximately 50 % were male and 50 % were female. The participants were natives of Europe, Asia, the Middle East and South America. Qualified participants had no work experience in biometrics and represented a range of educational and professional backgrounds.

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A.3.3 Procedure

Once the participants had completed a consent form and demographic questionnaire and had signalled their readiness, they were led to a preliminary room where they were given a brief introduction as well as the set of instructions to be used during their session. Half of the participants were then asked for their initial interpretations of the instructions before using the machine. After receiving the instructions, each of the participants was then lead to the testing room where they were asked to leave 10 fingerprints using the instructions that were provided. Participants' behaviours and comments were recorded manually by the test observer and three cameras captured each portion of the session.

Pressure and sensor-state data was recorded automatically by the fingerprint machine. After this data had been collected, a follow-up interview was conducted that included a task evaluation questionnaire.

A.3.4 Results

For the most part, participants paid very close attention to the instructions and interpreted them very literally. In general, participants understood what the instructions were asking them to do. Almost everyone understood the order and sequence of the capture. Any confusion stemmed from the symbols, icons and pictograms that provided additional information to the placement and positioning such as the pressure symbol, clock and OK/not OK symbols, icons and pictograms. When asked about the effectiveness of the paper instructions, most participants found them helpful. The most confusing part of the process to the participants was knowing when to remove their hand from the scanner. In general, participants interpreted the "OK" "time," and "Get help" symbols, icons and pictograms as intended.

The following key findings were identified.

— Participants expected that anything presented on the paper instructions would be replicated somewhere in the testing environment.

— The main cause of error or deviation from the desired sequence of activities occurred when the participant focused on a discrepancy between the paper instructions and testing environment.

— Participants stated their desire for some indication of whether or not their fingerprint had been successfully captured.

— Participants who paid most attention to the paper based instructions performed worse than those who paid the most attention to the sensor.

— On versions of the instructions where the "OK" and "not OK" symbols, icons and pictograms are presented, participants often had problems. These problems came initially from the interpretation of the "not OK" symbol meaning "do not do this" with an arrow pointing toward the correct symbol (i.e. the right four fingers, left four fingers or thumbs). We watched participants "not touching too hard" as well as "not placing all four fingers at once."

— The presence of the condition state ("OK" and "not OK") on the paper instructions led participants to believe that they would receive indication of completion during capture.

— Overall, participants (even those who interpreted it as intended) stated that the pressure or touch instruction is not necessary since it is already implied that they should touch or press their finger down on the scanner.

A.4 Guidance

A.4.1 Test participants

User testing demonstrated that the individual symbols, icons and pictograms are well understood by the general population.

It is important to test the symbols, icons and pictograms with participants of mixed educational backgrounds.

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A.4.2 Context of use

Testing also proved that context of use (as defined in ISO 9241-11) was critical for understanding the symbols, icons and pictograms. For the early testing in phase one, we asked participants to imagine they were entering customs and immigration in an airport and would be leaving a biometric such as a fingerprint or iris image. In the later stages of phase one testing, participants were provided the same scenario and shown a mock-up fingerprint scanner.

These participants were able to correctly identify more symbols, icons and pictograms.

A.4.3 Spatial relationships of symbols, icons and pictograms

How the symbols, icons and pictograms are grouped together is key to their understanding. Even though the individual symbols, icons and pictograms tested well, some groupings were misunderstood. The association of the icons together provides meaning. Therefore, the spatial relationships of the symbols, icons and pictograms to each other and the groupings themselves can be as important as the individual symbols, icons and pictograms. Consider the procedure in Figure A.1, with the pressure symbol and wait symbol aligned below the right hand symbol, participants were confused by the OK/not OK. They associated the OK/not OK with the pressure symbol and the wait symbol instead of step one of the process or the scan of the right hand. They incorrectly interpreted OK with do not press down. Aligning the pressure and wait symbols, icons and pictograms along the side of the finger positioning symbols alleviated some of this confusion.

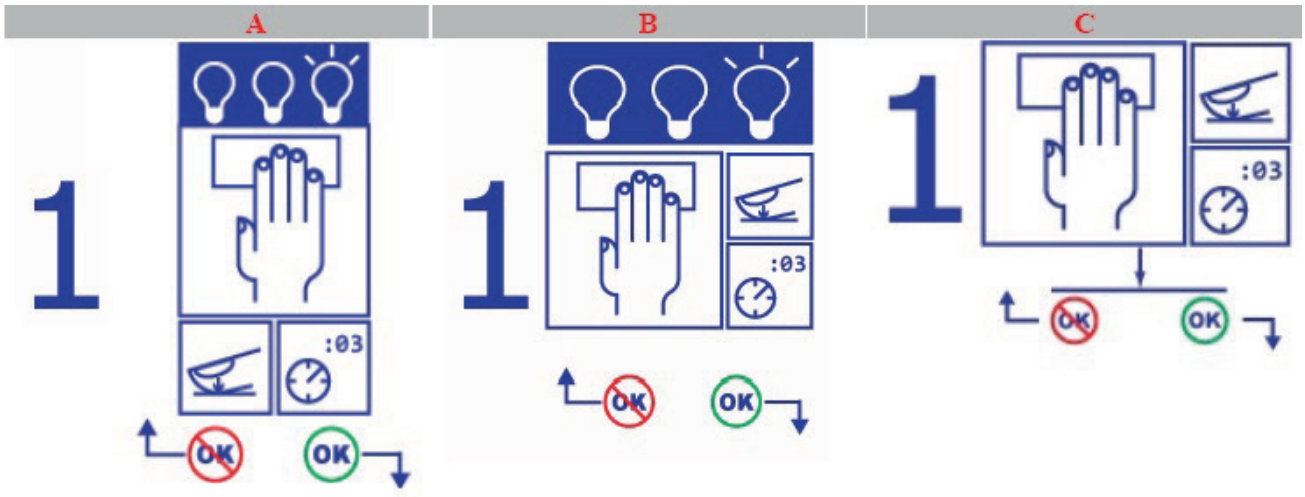

Figure A.1 — Spatial relationships of instructional elements

NOTE The light bulb symbol was not considered useful by the experts in the standardization process and was therefore not included in this document. Some of the symbols in this figure were changed in the standardization process.

But OK also caused some confusion. Again for some participants, the OK was associated with positioning the four fingers rather than with step one of the process. In this case, the procedure was interpreted as "I should not put all fingers down" but "I should put them down individually and hold for three seconds". Spatially separating the OK/not OK from the symbols, icons and pictograms assisted users in correctly identifying the OK/not OK with the grouping or step one as opposed to the individual symbols, icons and pictograms.

A.4.4 Location of symbols, icons and pictograms

— Test participants expected the symbols, icons and pictograms to appear on the device. They were confused when they did not see an OK/not OK on the device.

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Annex B
(informative)

Usability study of corrective visual guidance — Lateral, forward/backward and rotating movements

B.1 General

The National Institute of Standards and Technology's (NIST) Biometrics Usability group conducted a usability study to evaluate alternative visual guidance on lateral movement, forward/backward movement and rotating movement in an operational configuration with animations as recommended in Clause 5.

The corrective visual guidance evaluated is: move right, move left, move forward, move backward, rotate clockwise and rotate counter clockwise. For each movement, three alternatives were developed and tested. The differences among those alternatives are how the visual guidance is animated. Each corrective visual guidance has two components: a corner icon and a corrective arrow in the middle of the display space indicating the direction of the movement. The corrective arrow is always animated according to the intended direction of movement, e.g. the arrow is moving from right to left for the "Move Left" visual guidance. Three animation schemes were considered and developed with differences on the illustration of the corner icon:

1) The corner icon is static with no animation, showing the correct hand positioning, i.e. cent on the rectangle and upright.

2) The corner icon is static with no animation, showing the erroneous hand positioning, e.g. the hand is off to the right when the "Move Left" visual guidance is needed.

3) The corner icon is with a beginning-to-end animated sequence showing the hand moving from the erroneous position to the correct position.

With six movement categories and three alternatives for each, total of 72 animations were tested in this study as in Table B.1.

Table B.1 — Corrective visual guidance tested

	Right four fingers	Right thumb	Left four fingers	Left thumb
Move right	3	3	3	3
Move left	3	3	3	3
Move forward	3	3	3	3
Move backward	3	3	3	3
Rotate clockwise	3	3	3	3
Rotate counter-clockwise	3	3	3	3
Total	18	18	18	18

B.2 Method

A formative usability evaluation approach was performed in an operational configuration. The NIST's Biometrics Usability group developed an operational fingerprint scanning system that consists of a fingerprint scanning device, a computer program capable of detecting a subject's hand positioning and

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providing immediate visual feedback and an LCD monitor for displaying the real-time feedback to the subject.

There are six hand corrective categories to be evaluated that are applicable to right four fingers, right thumb, left four fingers and left thumb, as in Table B.1. For each fingerprint, a category has three alternatives. Due to the large number of animations in the evaluation, half of the subjects will only perform the tasks with their right hands (right four fingers and right thumb), and the other half will only perform the tasks with their left hands (left four fingers and left thumb). So, each subject will go through 36 corrective animations.

There were three tasks in the study:

Task 1 — Operational performance

This task asked each subject to move his/her hand on the scanner based on his/her instinct reaction to the visual guidance presented on the monitor.

Task 2 — Interpretation of visual guidance meaning

This task asked each subject to interpret the meaning of the visual guidance individually using his/her own words in an electronic survey.

Task 3 — Preference of alternatives

This task asked each subject to rank the alternatives for each category based on his/her preference.

The independent variables were

— correctness — whether the subject correctly follows the corrective visual guidance to the desired position/placement; the subject's hand movement will be recorded by the computer system as it is shown on the computer monitor,

— interpretation — whether the subject correctly interpret the meanings of the corrective visual guidance, and

— preference — prefers visual guidance among the three alternatives for each concept.

B.3 Subjects

Sixty subjects were recruited from the Washington, D.C. metropolitan area. The subjects ranged from 18 to 64 years old in age. Approximately 57 % were male and 43 % were female and represented diverse ethnic groups. Qualified subjects had no work experience in biometrics and represented a range of educational and professional backgrounds.

B.4 Procedure

Subjects participated in the study individually. Upon arrival at the NIST's usability lab, they were given a brief introduction about the study and asked to complete a consent form and demographic questionnaire. Half of the subjects were randomly assigned to the right-hand-only group, and the other half of the subjects were assigned to the left-hand-only group.

The test administrator then asked subjects to stand in front of the fingerprint scanning workstation and perform a practice task of neutral hand positioning without any corrective visual guidance, i.e. presenting right four fingers and right thumb, or presenting left four fingers and left thumb, based on the group assignment. When the subject indicated that he/she was ready, the test administrator started the test. The system displayed one corrective visual guidance at a time, waited for the subject to respond, and then displayed the next visual guidance, until all 36 animations were displayed. The sequence of displaying the visual guidance was randomized to eliminate any order effects.

Once going through all 36 animations on the scanning system, subjects were asked to fill out an electronic questionnaire with two parts. Since the animation schemes were the same for the four fingers and thumb, only the four fingers animations were included in the survey to control the participation

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time to be within 60 min. The first part asked the subject to interpret the meaning of each animation for the four fingers from the task and the second part asked the subject to rank the three alternatives for each category based on his/her preference.

B.5 Results

As there were no differences on performance between the hand assignment groups, the data from the two groups were merged. The correctness (%) from both the operational task and the interpretation task is summarized in Table B.2.

Table B.2 — Correctness results

	Performance correctness						Interpretation correctness		
	Four fingers			Thumb			Four fingers		
alternatives	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Move right	76,7 %	75,0 %	78,3 %	85,0 %	83,3 %	86,7 %	86,7 %	91,7 %	93,3 %
Move left	75,0 %	76,7 %	80,0 %	86,7 %	83,3 %	85,0 %	95,0 %	86,7 %	86,7 %
Move forward	86,7 %	90,0 %	88,3 %	93,3 %	93,3 %	93,3 %	95,0 %	91,7 %	96,7 %
Move backward	80,0 %	81,7 %	78,3 %	90,0 %	88,3 %	88,3 %	88,3 %	93,3 %	90,0 %
Rotate clockwise	86,7 %	85,0 %	83,3 %	91,7 %	95,0 %	93,3 %	56,7 %	56,7 %	63,3 %
Rotate counter-clockwise	8,7 %	85,0 %	85,0 %	91,7 %	95,0 %	91,7 %	65,0 %	66,7 %	55,0 %

In the operational task, subjects performed very well instinctively (all above 75 % of correctness) with all three alternatives for all movement and rotation categories. For each category, there were no significant differences among the three alternatives using the Related Samples Cochran's Q Test.

In the interpretation task, the correctness was very good for the movement categories but not as good as the performance correctness. However, it was much lower for the rotation concepts. It was observed that some of the subjects were not comfortable using the keyboard to type their answers due to their experience with technologies and some subjects had some difficulties finding vocabulary to describe the visual guidance due to their educational or ethnic backgrounds. They often used words such as "tilt" or "slant" to describe the turning or rotating of the hand in interpreting the rotation concepts. Using the non-parametric Related Samples Cochran's Q Test, there were no significant differences among the three alternatives for all categories, except for the "Move Left" in which alternative 1 is significantly better than alternatives 2 and 3 (both with $P < 0,05$).

In the preference ranking task, subjects saw all three alternatives side by side and ranked them from 1 (like the most) to 3 (like the least) for each category. The average ranking scores are summarized in Table B.3. Alternative 3 was liked the most significantly across all categories (all with $P < 0,05$), using the non-parametric Friedman Test.

Table B.3 — Preference rankings on alternatives

	Average Preference Ranking		
Alternatives	**1**	**2**	**3**
Move forward	2,36	2,07	1,56
Move backward	2,57	2,08	1,35
Move right	2,82	1,84	1,33
Move left	2,73	1,92	1,35
Rotate clockwise	2,71	1,88	1,40
Rotate counter-clockwise	2,81	1,98	1,21

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In summary, subjects responded to the directional visual guidance for “Move right,” “Move left,” “Move forward,” “Move backward,” “Rotate clockwise,” and “Rotate counter clockwise” very well. They understood the large directional arrow communicating the direction of the desired movement. In addition, the animation helped guide them with the movement accordingly. While, in most cases, no significant differences were found from the operational and the interpretation tasks among the three alternatives, it is clear that subjects prefer to have the animation (alternative 3) showing the beginning-to-end sequence, i.e. hand moving from the erroneous position to the correct position.

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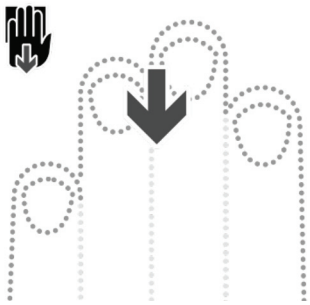
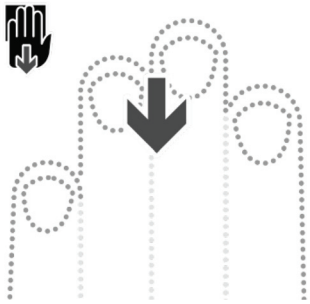
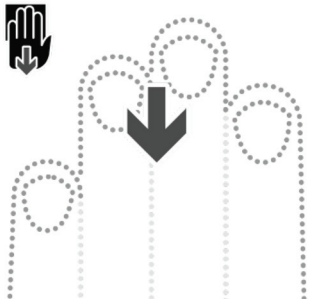
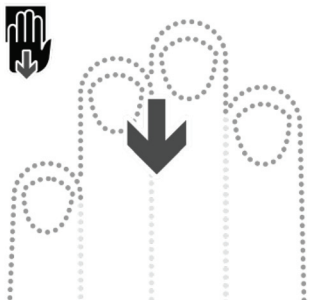
Annex C
(informative)

Stepwise illustrations of the animation of Figure 30

Frame number	Illustration	Duration (seconds)
Frame 01		0,5
Frame 02		0,3
Frame 03		0,3
Frame 04		0,3

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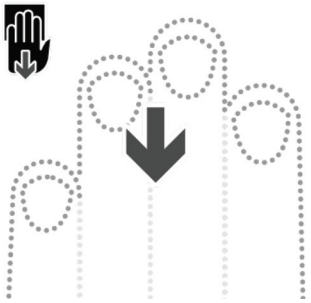
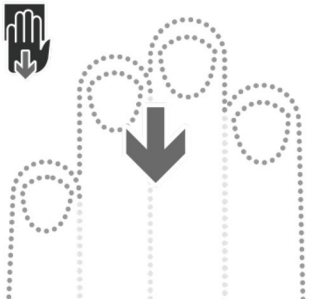
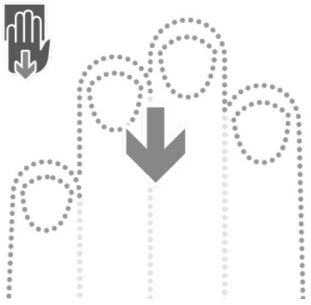
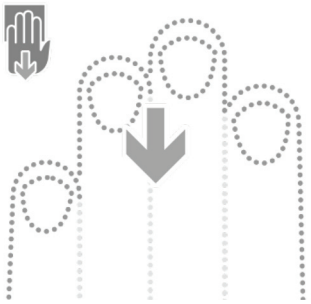
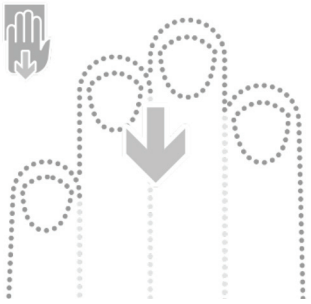
Frame number	Illustration	Duration (seconds)
Frame 05		1,5
Frame 06		0,1
Frame 07		0,1
Frame 08		0,1
Frame 09		0,1

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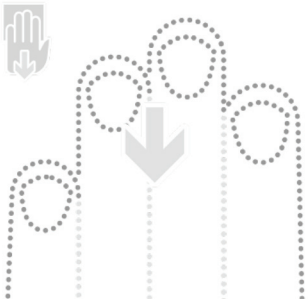
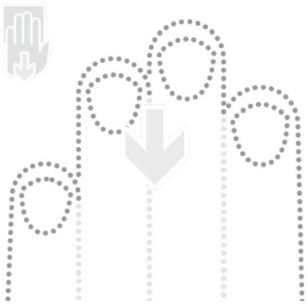
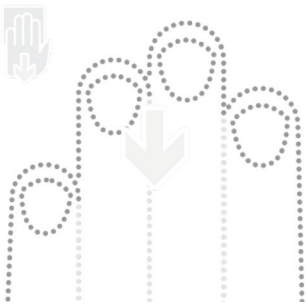
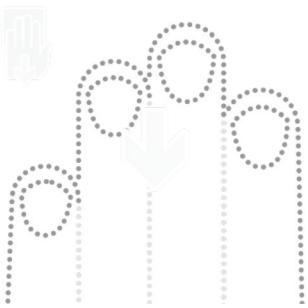
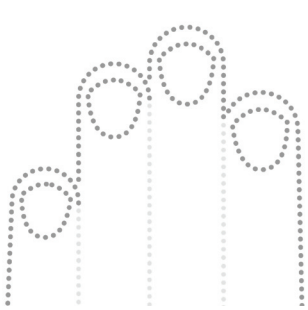
Frame number	Illustration	Duration (seconds)
Frame 10		0,1
Frame 11		0,1
Frame 12		0,1
Frame 13		0,1
Frame 14		1,0

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3) The graphical symbol collections of ISO 7000, ISO 7001, ISO 7010 and IEC 60417 are available on line in the ISO web store, http://www.iso.org/iso/home/store/graphical_symbols.htm. All graphical symbols can be previewed on the Online Browsing Platform (OBP), https://www.iso.org/obp/ui/#search.

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