

NIST Contribution to ISO/IEC JTC1 SC37 WG 6, 24779: Pictograms, Icons and Symbols for use with Biometric Systems

Overview

The following document contains a set of symbols and pictograms to help the general public understand the concepts and procedures for using electronic systems that collect and/or evaluate fingerprints. The proposed set of symbols and pictograms are designed to be used to:

- Identify the type of biometric sensor
- Provide static instructions related to a fingerprint sensor
- Display dynamic information related to the fingerprint sensor
- Indicate the status of the fingerprint sensor.

To provide this functionality, the proposed set of symbols includes both directional symbols and action or feedback symbols. The fingerprint sensor symbols include:

- Finger placement:
 - Index finger (right/left)
 - Thumbs (individual and both)
 - Slap (4 fingers) (right/left).
- Sensor Ready state
- Scan
- Start Capture
- Press (more or less)
- Wait or Hold
- Successful capture
- Unsuccessful capture
- Repeat or Retry
- Next step
- Completed process successfully
- Give-up or completed process unsuccessfully.

Although the symbols are presented individually, it is intended that the symbols be combined to fully illustrate the fingerprinting interaction. For example in a customs or immigration environment procedures constructed from the individual symbols and pictograms could be presented as:

- A series of posters while passengers are in the queue
- A series of transitional frames in a biometric booth

- An animated video or series of transitional frames while passengers are in the queue
- Instructional leaflets for passengers to read in the queue

The symbols and pictograms included in this document have undergone usability testing. The symbols 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 were to be used and asked each participant to identify the meaning of each symbol 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 or pictograms. A more complete description of the testing procedures and results are presented in Appendix A.

Individual Symbols

Ready State

The device must have an indicator that conveys the device is ready and that fingerprinting can begin. For the visual instructions this can be generalized as a OK state with “light bulbs”. For visual indicators on the device itself, a simple OK icon without the light bulbs will suffice.

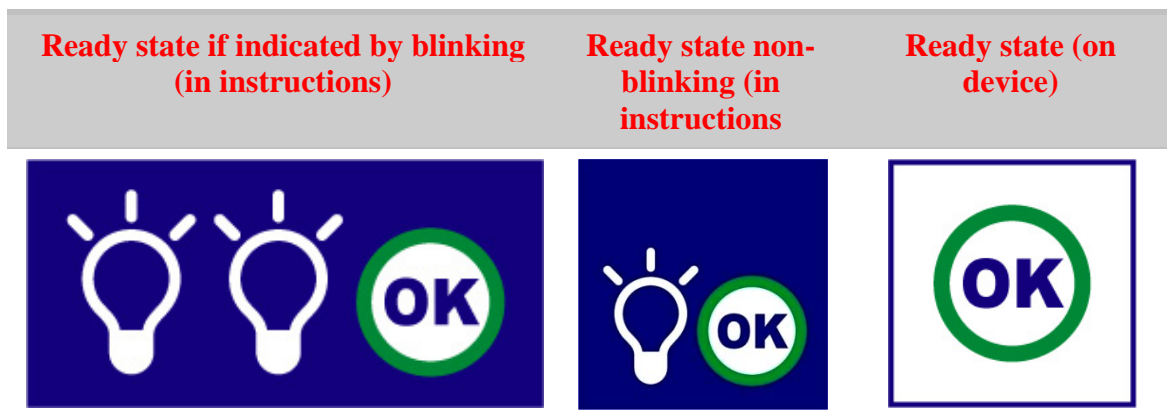


Figure 1 Ready state

Finger Placement

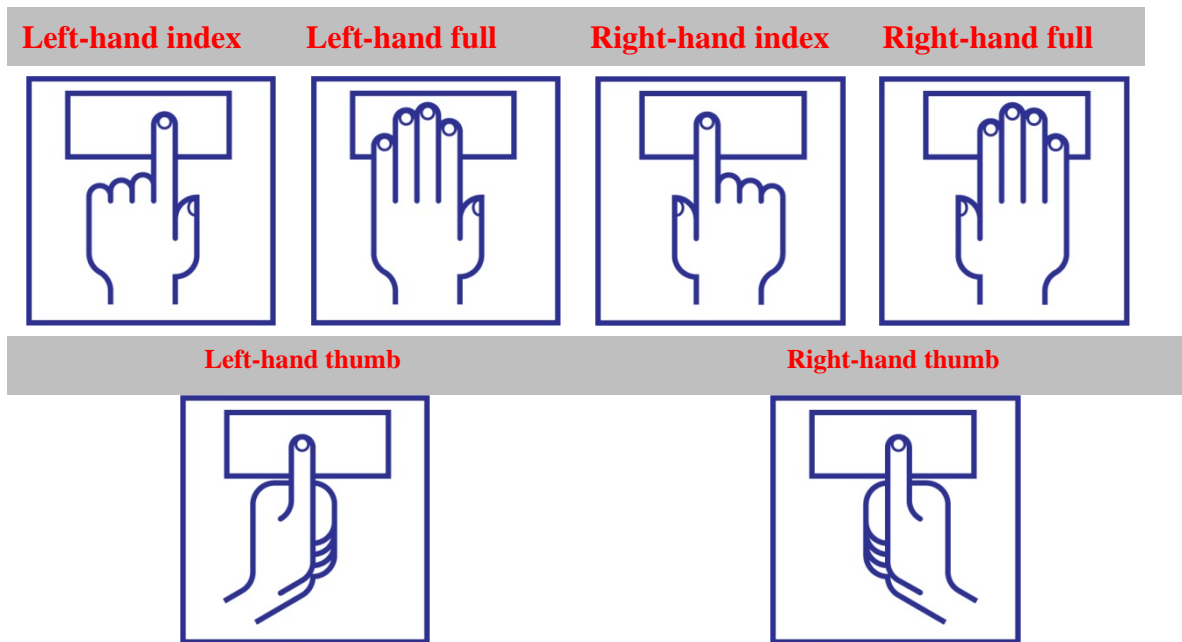


Figure 2 Full hand procedure – single thumbs



Figure 3 Dual thumbs

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 should be accompanied by a consistent profile image (see Figure 5 Press, increase/decrease pressure) to reinforce pressing and not hovering.

Wait/Hold

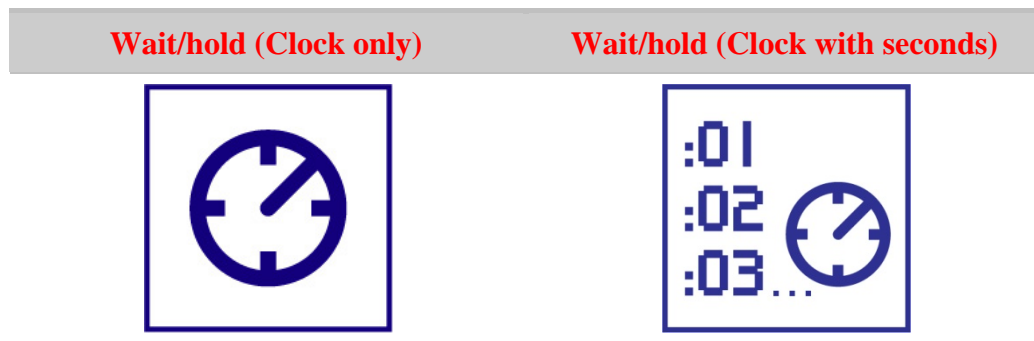


Figure 4 Wait/hold

The device must naturally have a time constraint or criteria in which it determines that the capture is acceptable. One version includes some seconds, to encourage users to count. This alternative would be ideal for the visual procedure. However, on the device itself, a simple clock indicator (without the seconds) may suffice, as the device may provide enough context about what is taking ‘time’. If the devices have a standard ‘waiting’ time for captures, the numbers should be altered to reflect that. The computer-oriented hourglass was specifically not use as it requires the user to have computer experience.

Press More/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 may suffice, as the device may provide more context about what is ‘more’ or ‘less’ required

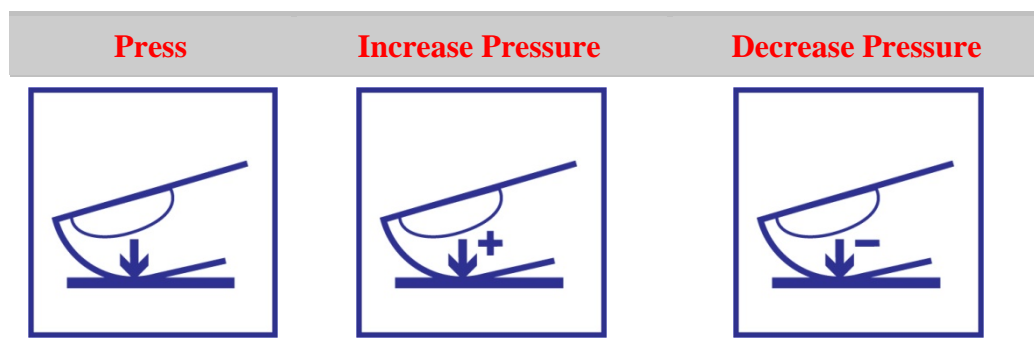


Figure 5 Press, increase/decrease pressure

Figure Acceptable/ Unacceptable Capture

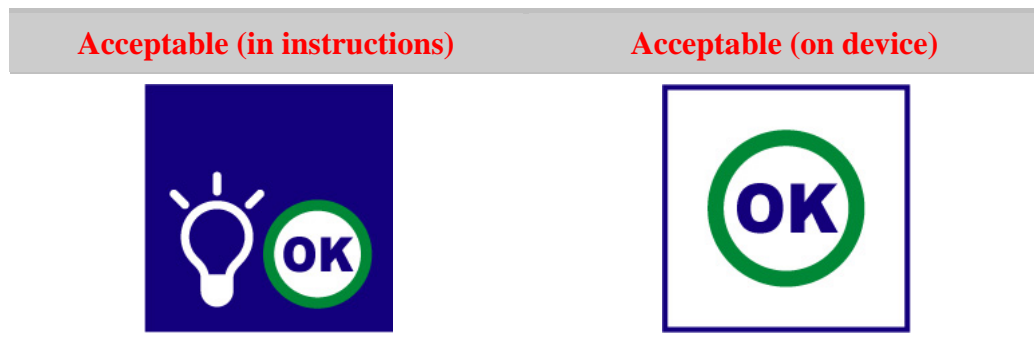


Figure 6 Acceptable capture

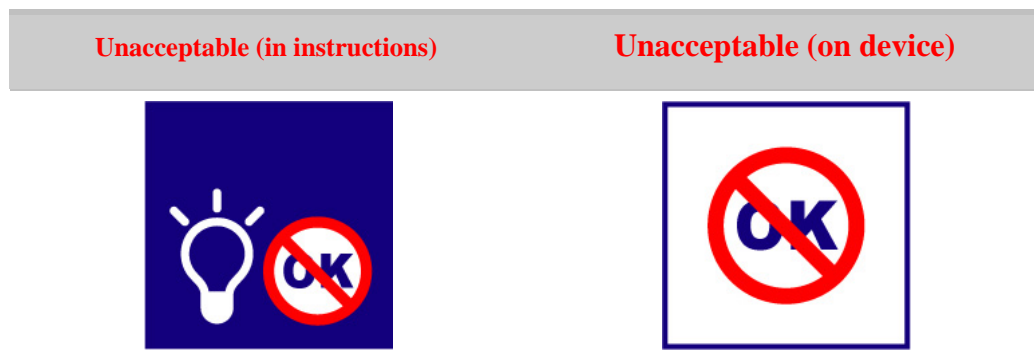


Figure 7 Unacceptable capture

It is assumed that the device must have dynamically appearing feedback indicators (like LCDs) to indicate to users that their capture is acceptable or unacceptable. Therefore, in the visual procedure, 'light bulb' symbols are included to represent OK/~~OK~~ feedback from the device. Without them, the OK/~~OK~~ might convey that a preceding or forthcoming action is allowed or forbidden. For visual indicators on the device itself, a simple OK or ~~OK~~ icon without the light bulbs will suffice.

Retry

The device requires an indicator that indicates the capture must be retried. In the visual procedure, 'light bulb' symbols were included to represent OK/~~OK~~ feedback from the device. Without them, the OK/~~OK~~ might convey that a preceding or forthcoming action is allowed or forbidden. If a capture was unacceptable, directional arrows leading to the previous step indicate a retry. On the device, if the retry does not start automatically after the platen is pressed, the Retry symbol may be used as a button icon.





Figure 8 Retry

Give-up/Exit

In both the visual procedures and the on-device indicators, a 'give up' command or status must have some sort of associated or implicit action: presumably, the user leaves the device, and perhaps proceeds to an immigration or customs agent for assisted biometric capturing.

Conversely, if the captures are indeed acceptable and the procedure complete, there may be a similar indicator or action to denote an appropriate exit. These have been depicted below.

Give up (after unacceptable captures)



Figure 9 Give up – unacceptable capture

Exit (after successful captures)



Figure 10 Exit – acceptable capture

Procedures

As previously described it is intended that the symbols be combined to fully illustrate the fingerprinting interaction and provide visual fingerprinting procedures. The following examples combine all of the symbols into a pair of fully illustrated fingerprinting procedures. The first describes a procedure for capturing the right and left index fingers followed by the right and left thumbs. The second illustrates a ten-finger capture.

The symbols and associated procedures attempt to accommodate all variations of fingerprint devices (device independent) and all nationalities of passengers. To achieve these objectives the procedures have been assembled with the following considerations:

1. Visualization from top to bottom in a single column to accommodate readers of all directional scripts
2. Presentation in blue to denote that these symbols are indicative – to instruct and indicate, rather than show prohibition (red). Mandate (green), warning or caution (yellow).
3. Including “light bulb” symbols to represent OK/~~OK~~ feedback from the device. Without them, the OK/~~OK~~ might convey that a preceding or forthcoming action is allowed or forbidden.
4. Distinguished pictographic fingerprinting instruction from the device feedback OK/~~OK~~ by reversing the color (blue-on-white versus white-on-blue).

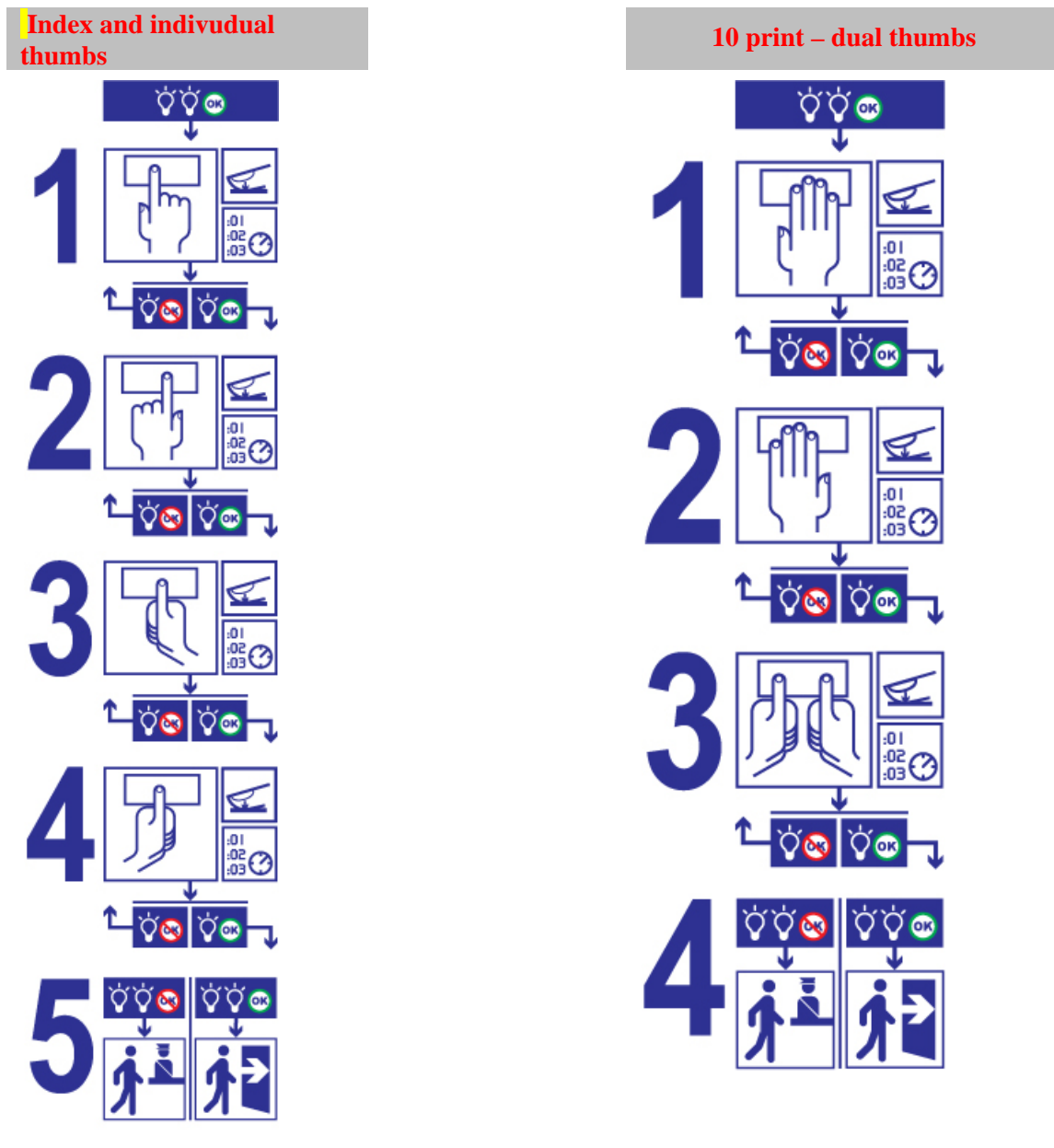


Figure 11 Full capture procedures

Guidance

Test Participants

User testing demonstrated that the individual symbols or pictograms are well understood by the general population (Appendix A). The testing also showed that test participants with a scientific background were better at identifying symbols that were more abstract. Thus it is important to test the symbols with participants of mixed educational

backgrounds. The set of abstract symbols that were tested and rejected are presented in Appendix B.

Context of Use

Testing also proved that context of use (as defined in ISO 9241-11:1998) was critical for understanding the symbols. 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 (Appendix A).

Spatial Relationships of Symbols

How the symbols and icons are grouped together is key to their understanding. Even though the individual symbols tested well some groupings were misunderstood. The association of the icons together provides meaning. Therefore, the spatial relationships of the symbols to each other and the groupings themselves may be as important as the individual symbols. Consider the procedure in Figure 12 Spatial relationships of instructional elements, with the pressure symbol and wait symbol aligned below the right hand symbol participants were confused by the OK/OK. They associated the OK/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 don't press down. Aligning the pressure and wait symbols along the side of the finger positioning symbols as in Figure 12 Spatial relationships of instructional elements alleviated some of this confusion.

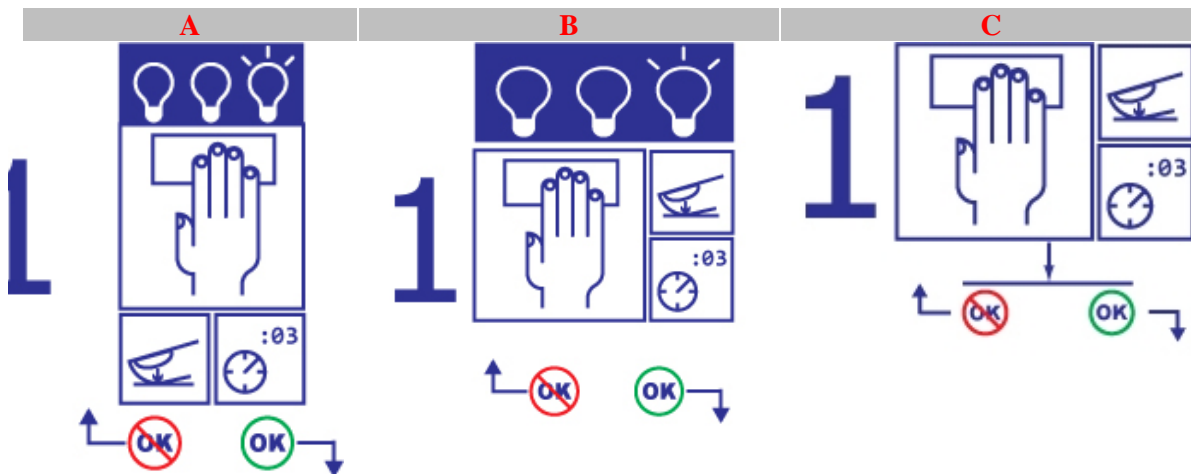


Figure 12 Spatial relationships of instructional elements

But Figure 12 Spatial relationships of instructional elements 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/OK from the symbols as in Figure 12 Spatial relationships of instructional

elements assisted users in correctly identifying the OK/~~OK~~ with the grouping or step one as opposed to the individual symbols.

Device Dependence

If possible the symbols and icons should mimic the device as closely as possible, for instance the relative size of the platen in relation to the fingers. As another example, the test participants expected the symbols to appear on the device. They were confused when they did not see an OK/~~OK~~ on the device.

Additional Symbols

Symbols to identify biometric modalities (fingerprint, iris, face, voice), positioning and directions for face and iris, facial pose instructions, and finger positioning including directions for rolled prints have been designed. These symbols and icons are currently undergoing testing and will be submitted in the next revision.

Acknowledgments

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Appendix A: Usability Testing Approach

The National Institute of Standards and Technology's (NIST) Biometrics Usability group designed a series of usability tests to investigate user's comprehension and understanding of the proposed symbols and icons. The symbols 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 and icons to interact with fingerprint scanners.

User Interviews

Method

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

1. Ready State
2. Fingerprinting on the platen
3. Start Capture
4. Wait/Hold
5. Press more/less
6. Acceptable/unacceptable capture
7. Retry
8. Give up/exit.

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

Participants

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

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 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. For the first nine participants, we asked them to imagine that you are visiting another country and are approaching customs and immigration at the airport, these symbols might be displayed to describe the biometric process to you. 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 was printed on a separate sheet of paper. Each participant was asked the meaning of each symbol or pictogram. Once the participant had viewed each individual symbol then the procedure or process was presented. Again the participant was asked to describe the meaning of the process.

Results

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

Table 1 Symbol Interpretation

Higher Context Below

Correct Approximate Incorrect

Task Based Testing

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

Method

A formative usability testing approach was used for phase two testing. This testing was task-based modeled 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.

Participants

Forty-four participants who spoke English as a second language were recruited from a Washington, DC –area database of study volunteers. The participants ranged in age from 25 to 70 years old. 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.

Procedure

Once the participants had completed a consent form and demographic questionnaire and had signaled their readiness, they were lead 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' behaviors 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

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 that provided additional information to the placement and positioning such as the pressure symbol, clock, and OK/not OK symbols. 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 “redo,” “time,” and “get help” symbols as intended.

The following key findings were identified (these findings have already been summarized in the Guidance section of the document):

- 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 are presented, participants often had problems. These problems came initially from the interpretation of the red “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” & “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 you should touch or press your finger down on the scanner.

Appendix B: Alternate Symbols

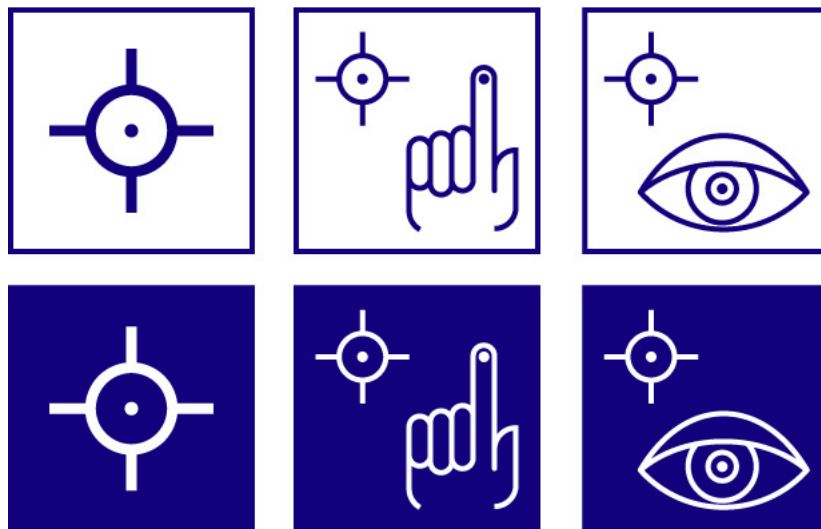
The following symbols were tested during the user interviews and usability testing and were found to be difficult to comprehend or prone to misunderstanding. Most are alternates to symbols that were proposed in this document. They are presented here for completeness.

For those categories of symbols where none of the symbols performed well, new symbols are currently under development and testing.

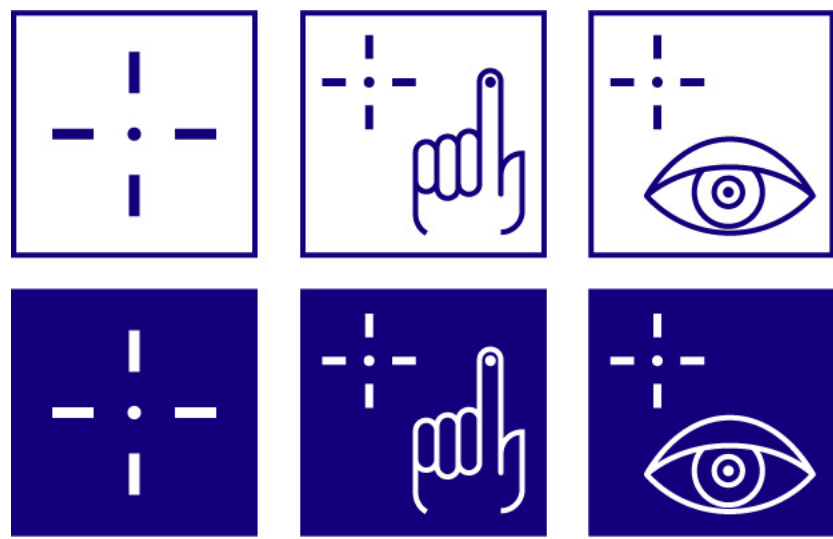
Start capture

- The device must have an indicator that indicates the capture is starting or in progress
- Alternatively, if the capture does not start a few moments after the platen is pressed, the Start capture symbol may be used as a button icon.
- There may also be a need to distinguish finger and eye-capturing on one device.

Start capture (Alt 1: circular cross)

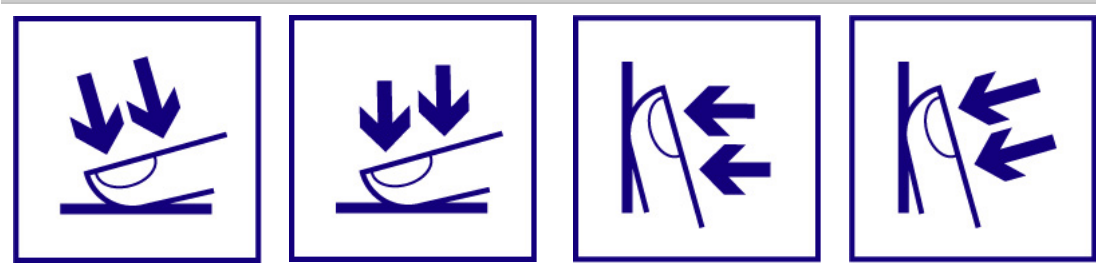


Start capture (Alt 2: crosshair)

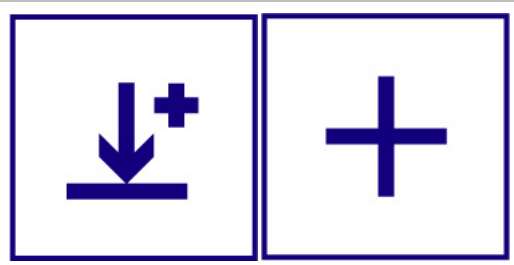


Press more/less

Press more (down): Alt 1 + Alt 2 Press more (rotated): Alt1 + Alt 2



Press more (abstract): Alt 1 + Alt 2



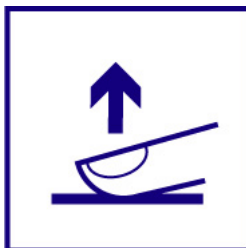
Press less (down): Alt 1 + Alt 2



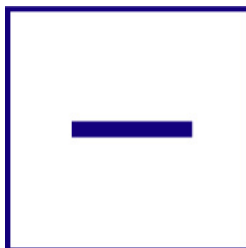
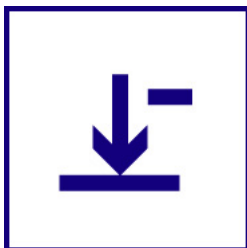
Press less (rotated): Alt 1 + Alt 2



Press less (not prohibitive)



Press less (abstract): Alt 1 + Alt 2



Exit

Exit (abstract)

