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Information technology — Scenario evaluation methodology for user interaction influence in biometric system performance

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

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Introduction

This document describes a methodology for testing and reporting user interaction influence on the performance of biometric recognition systems. Specifically, it describes a methodology for testing and reporting that influence.

The performance of biometric systems can vary or can be influenced by user interaction influence factors. According to ISO/IEC 19795-1:2021, C.2, user physiology, user behaviour, sensors and hardware (all user interaction influence factors) are some factors that can influence the performance of a biometric system.

This methodology is a scenario test in which a set of test subjects interacts with a biometric system to execute transactions when one or more of the following factors is controlled:

— Factors related to the design, position or condition of the capture system.

— Factors depending on the users and their attributes.

— Factors depending on the user interaction with the biometric system.

Testing user interaction influence can be subjective and is not necessarily straightforward. Therefore, this document is intended to address the main conflicts that arise in such cases.

Within the context of this document, it is important to differentiate between “usability testing” and “user interaction influence in performance”. Usability testing relates to “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO/IEC 9241-11:2018). Usability testing involves the measurement of “how usable” a specific system or product is. Usability testing is addressed in documents including ISO/IEC TR 25060. On the other hand, "user interaction influence in performance" deals with measuring how the performance of a biometric system can differ from a reference evaluation, based on subjects using the system in operational or scenario conditions.

Information technology — Scenario evaluation methodology for user interaction influence in biometric system performance

1 Scope

This document addresses:

— requirements for planning, executing and reporting the influence of user interaction on biometric system performance based on scenario test methodologies, considering three kinds of factors:

  a) factors related to the design, position or condition of the capture device;

  b) factors depending on users and user attributes,

  c) factors depending on the interaction of users with the biometric system;

— specifications for the definition, establishment and measurement of conditions needed for evaluation, including those relating to equipment;

— requirements for establishing a reference evaluation condition (REC) and target evaluation condition(s) (TEC) to compare the influence of user interaction factors;

— a specification of the biometric evaluation including requirements for test population, test protocols, data to record, test results; and

— procedures for carrying out the overall evaluation.

This document does not:

— determine which parameters ought to be analysed for a specific biometric modality. This is currently covered in ISO/IEC TR 19795-3;

— specify requirements for performing a vulnerability analysis modifying user interaction influence factors;

— include procedures for performing usability testing.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 19795-1, *Information technology — Biometric performance testing and reporting — Part 1: Principles and framework*

ISO/IEC 19795-2, *Information technology — Biometric performance testing and reporting — Part 2: Testing methodologies for technology and scenario evaluation*

ISO/IEC 2382-37, *Information technology — Vocabulary — Part 37: Biometrics*

ISO/IEC 24779 (all parts), *Information technology — Cross-jurisdictional and societal aspects of implementation of biometric technologies — Pictograms, icons and symbols for use with biometric systems*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19795-1, ISO/IEC 2382-37 and the following apply.

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

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

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

3.1
reference evaluation condition
REC
test condition reflecting established device factors, user factors or user interaction factors

Note 1 to entry: Results generated under these test conditions are compared against results generated under corresponding *target evaluation conditions* (3.2).

3.2
target evaluation condition
TEC
test condition reflecting new or alternative device factors, user factors or user interaction factors

Note 1 to entry: Results generated under these test conditions are compared against results generated under corresponding *reference evaluation conditions* (3.1).

3.3
user interaction influence in performance
measurement of how the performance of a biometric system can differ from a reference evaluation, based on subjects using the system in operational or scenario conditions

3.4
usability testing
testing relating to the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use

Note 1 to entry: See ISO/IEC 9241-11.

4 Conformance

To conform to this document, a user interaction influence performance evaluation shall implement the requirements contained herein, including one reference evaluation condition (REC) and at least one target evaluation condition (TEC).

5 Overview

5.1 General

Testing the influence of user interaction in the performance of a biometric system entails execution of one scenario evaluation under reference evaluation conditions (REC) and at least one evaluation under target evaluation conditions (TEC). These evaluations are identical except for changes to the user interaction influence factors being studied.

For each set of condition(s), test subjects interact with the biometric system as many times as required. The number of times the interaction is repeated shall be defined at the time of the evaluation design, considering parameters such as: available time for the evaluation, availability of test crew, effort to be applied for each test crew subject, cost, etc. Biometric system recognition outcomes and (optionally)

test subject interactions are recorded. From such results, it is possible to calculate biometric system performance (e.g. error rates and throughput rates) for the specific evaluation condition(s).

By comparing performance results generated under REC and TEC, the influence associated with user interaction factor(s) can be quantified. A schema of the evaluation methodology model is shown in Figure 1. In scenario evaluations, biometric systems are assessed in modelled environments considering a real-world target application and population. Requirements for scenario testing and reporting are defined in ISO/IEC 19795-2.

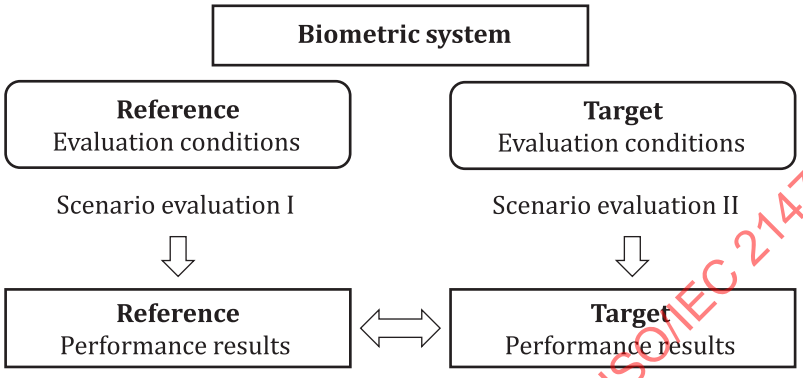

Figure 1 — Methodology evaluation schema of user interaction influence in biometric system performance

Each evaluation condition is specified to analyse one or a combination of user interaction influence factors. The evaluation methodology allows for conditions to be tailored according to the objectives of the evaluation. These objectives can consider three general aspects:

— the design, position or condition of the biometric system and/or its biometric capture device;

— the potential users, their attributes or the state of such attributes;

— parameters that can affect the interaction process such as guidance, training or feedback.

Depending on the biometric system, its capture device, the potential users and the final application, certain aspects are more critical than others. ISO/IEC TR 19795-3 discusses modality-specific aspects that can be relevant to user interaction influence testing. Parties involved in the evaluation shall select which aspects are indispensable for analysis. TEC can encompass one or multiple user interaction influence factors.

5.2 User interaction influence factors

In order to compare TECs and RECs, it is also necessary to define the user interaction influence factors. There are three kinds of factors in the interaction between users and biometric systems:

— Factors depending on the biometric capture device, e.g. design, position or condition.

— Factors depending on users and user attributes, e.g. physical features or experience with the device.

— Factors depending on the interaction of users with the biometric system, e.g. feedback provided by device to user.

6 Evaluation conditions specification

6.1 General

The individual(s) carrying out the experiment shall specify the user interaction influence conditions to be evaluated, taking into consideration the following:

— user interaction influence factors;

— RECs and TECs;

— enrolment and recognition-based factors.

6.2 Specification of user interaction influence factors

6.2.1 General

The definition of the evaluation conditions consists of determining which user interaction influence factors will be assessed. The different kinds of factors that can be selected are provided in the following subclauses. Other factors that can be measured may be considered.

6.2.2 Factors depending on the biometric system

User interaction can be influenced by the design, position or condition of the biometric capture system. These factors, examples of which are listed in Table 1, can cause the failure of the biometric capture process or result in a biometric sample of poor quality. Table 1 categorizes factors as software- and hardware-related, and includes an example for each factor and/or its possible variations.

Table 1 — Examples of system-dependent user interaction influence factors

Type	Factor			Example REC	Example TEC 1	Example TEC 2
Software	Process	Location		Remote server-based matching	Embedded matching	
Hardware	Position	Height		Device positioned at 1,20 m height	Device positioned at 1 m height	Device positioned at 1,50 m height
		Orientation	Rotation	Swipe sensor horizontally	Swipe sensor vertically	
			Incline	On a table without inclination	On a table with 15º inclination	On a table with 30º inclination
		Mobility		Attached to a wall	Embedded in a mobile device	
	Condition			Clean sensor	Dirty sensor	

6.2.3 Factors depending on the user

The users' attributes (including biometrics) can also affect the process of capturing the biometric sample. User interaction influence factors can be associated with a test subject (i.e. the person who presents biometric characteristics).

In this document, the users are the participants of the evaluations or the personnel who interact with the biometric devices/system (depending on the evaluation characteristics). Guidance on best practice and on how to measure the operators' influence in the evaluations' performance is provided in ISO/IEC TR 29189. Further information on the accessibility and usability of biometric systems is given in ISO/IEC TR 24714-1 and in ISO/IEC TR 29194.

Table 2 categorizes user interaction influence factors as behavioural and physical and includes illustrative examples of REC and TEC. The categorization into behavioural and physical types, as well as the classification of factors, is for illustration only. Again, these factors can cause the failure of the biometric capture process or result in a biometric sample of poor quality.

Table 2 — User interaction influence factors depending on the user

Type	Factor		Example REC	Example TEC 1	Example TEC 2
Behavioural	Speech	Language	Speakers from Spain speaking Spanish	Speakers from Mexico speaking Spanish	Speakers from China speaking Spanish
		Voice	Speakers talking at a certain volume	Speakers talking louder	Speakers with regional dialects
	Movements		Users showing neutral expression	Users smiling	
	Experience		Users habituated to using the system	Users non-habituated to using the system	
	Knowledge		Users who do not have technical knowledge	Users who have technical knowledge	Users who have biometrics knowledge

Table 2 *(continued)*

Type	Factor			Example REC	Example TEC 1	Example TEC 2
Physical	Anthropometric data	Body dimensions		Users between 181 cm and 200 cm tall	Users between 140 cm and 160 cm tall	Users between 161 cm and 180 cm tall
		Physical features		Right-handed users	Left-handed users	
	Demographics	Age		Users aged between 20 yrs and 40 yrs	Users aged between 40 yrs and 60 yrs	Users aged between 61 yrs and 80 yrs
		Gender		Women	Men	
		Ethnic origins		African American users	Japanese users	Russian users
		Occupation		Users who work with a computer	Manual laborers	
	Interaction-influential	Fixed	Natural	Users who do not have a beard	Users who have a beard	Users who have long hair
			Artificial	Users who do not have a tattoo on the face	Users who have a tattoo on the face	
		Non-fixed	Natural	Users having dry hands	Users having sweaty hands	
			Artificial	Users who wear glasses	Users who do not wear glasses	Users who wear earrings
	Other factors			Users with vision problems	Users without vision problems	
				Users with a speech impediment	Users without a speech impediment	
				Users who cannot provide biometric characteristics	Users who can provide biometric characteristics	
				Users with dyslexia	Users without dyslexia	

6.2.4 Factors depending on the user-biometric system interaction

Table 3 describes the factors relating to the interaction of the user with a biometric system. Again, these factors can impact the capture of a biometric sample. Some of the variations and examples are intended to emulate good faith but low-quality or mildly non-compliant presentations.

Table 3 — User interaction influence factors depending on the user-biometric system interaction

Type	Factor		Example REC	Example TEC 1	Example TEC 2
User-biometric system interaction	Guidance	Assistance	Personal guidance during the process	Video guidance during the process	Audio guidance during the process
		Instructions	Without previous instructions	With previous visual instructions in posters	
	Habituation		Without previous habituation	With previous habituation	
	Feedback		Without feedback	Receiving acoustic feedback indicating the correctness of the presentation	Receiving visual feedback indicating the correctness of the presentation
	Environment		On a mobile device, alone in an office environment	Using a mobile device in a crowded space	

6.3 Specification of the evaluation conditions

6.3.1 General

The factors to be assessed for the REC and TEC(s) shall be specified. These factors determine the evaluation conditions, which shall consider the different phases of a biometric performance scenario evaluation, i.e. enrolment and recognition. An overview of the detailed specification is shown in Figure 2.

Firstly, the evaluation factors to measure shall be decided upon by the parties involved in the evaluation. This decision should be based on parameters such as the biometric modality of the system under test, the type of technology used by the capture devices and the target application, as well as the target population. At this point, it is recommended to refer to ISO/IEC TR 19795-3, which lists factors that can impact biometric performance for certain modalities. Next, the particular specification for all the defined evaluation factors shall be established. The specification for each evaluation condition shall conform to the requirements that are given in the text below. These requirements have been established considering different evaluation objectives as well as whether the intended application and the target population are known.

When specifying the evaluation conditions, only the factors for analysis and the scenario evaluation aspects involving such factors shall be selected. The rest of the evaluation conditions shall be defined according to a biometric performance scenario evaluation (ISO/IEC 19795-2). Performance under each condition shall be reported.

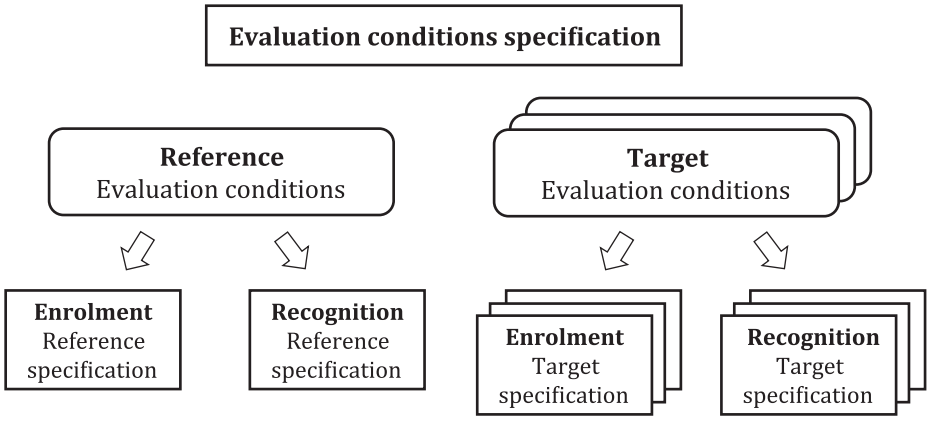

Figure 2 — Evaluation conditions specification

6.3.2 Specification of reference evaluation conditions (REC)

In order to establish REC, there are several possibilities based on the typical values of the target application/population or conventional conditions. Each tester will define their own REC which is not meant to be a general reference applicable to all tests or environments. It is not possible to determine the typical values of the target application/population in advance, but some conventional conditions are provided for each group of factors:

— For factors depending on the biometric system, conventional conditions follow developers' recommendations.

— For factors that depend on the users or user attributes, a typical reference can be one where test subjects do not have any component that affects or covers the biometric characteristic, i.e.:

  — Physical elements: test subjects shall not wear any element that covers, partially covers or can affect the biometric characteristic capture process. Moreover, it is desirable that the biometric characteristic is not damaged.

  — Chemical products: test subjects shall not have used any chemical product that can affect the interaction.

— For factors that depend on the interaction process, a typical reference may be that test subjects present their biometric characteristic in compliance to developers' recommendations. If developers' recommendations are not available, test subjects shall be provided with consistent, clear directions on usage to ensure that this factor does not inappropriately disrupt performance measurement.

6.3.3 Specification of target evaluation conditions (TEC)

The evaluator shall specify TEC(s) encompassing factors that enable evaluation of user interaction influence. TEC(s) shall be paired with an REC.

6.3.4 Enrolment-related considerations in REC / TEC

Test subjects are enrolled as part of a scenario test. The evaluator shall specify enrolment processes, including whether enrolment is considered part of the RECs and TECs.

For example, an evaluation can have one enrolment process for all users, followed by recognition tests whose RECs and TECs vary. In this case, the evaluator can be measuring matching accuracy and other rates such as the failure-to-acquire rate, FTAR, or failure-to-enrol rate, FTER, (see ISO/IEC 19795-1) for the REC and TEC.

Alternatively, an evaluation can have a reference enrolment condition and a target enrolment condition in order to measure user interaction influence on enrolment performance. This can be followed by recognition tests whose reference and TECs vary. In this case, the evaluator can be measuring matching enrolment rates and accuracy for the REC and TEC.

6.3.5 Recognition-related considerations in REC / TEC

To the degree possible in the scenario evaluation, the REC and TEC specifications shall reflect the actual or intended use of the system for recognition.

EXAMPLE The RECs and TECs can be designed to emulate an unsupervised application in which up to three attempts at recognition are allowed before declaring a transaction a failure to acquire.

6.4 Generation of the evaluation conditions

RECs and TECs shall be defined and satisfied for any performance evaluation test. Processes for generating or satisfying evaluations differ based on the aspects under evaluation. Typical activities include the following:

— Factors that depend on the biometric system, for which it is essential to configure the system as defined in the evaluation conditions. This can require the use of a facility which models the desired operational location of the system.

— Factors that depend on the user (the population demographic, specific user behaviours or user attributes). These should be addressed both in the selection of test subjects and the test design to ensure that the effect of these factors can be observed and quantified. For example, test subjects should be chosen specifically to represent a relevant group with whom certain factors are likely to be observed to affect performance. It can be necessary to include simulation of certain conditions or behaviours (e.g. subject has wet/dry/greasy hands or the subject looks away) in the test protocol in order to observe and measure their effect.

— Factors that depend on the interaction process. For these factors, it is necessary to develop guidelines with standardized pictograms, icons and symbols (according to ISO/IEC 24779-1) for instructing test subjects about how they shall present their biometric characteristics to the biometric system in accordance with the evaluation conditions specifications for the RECs/TECs.

6.5 Control of the evaluation conditions

Test operators shall monitor and instruct test subjects as necessary to ensure that they participate according to the REC/TEC in question. They shall also ensure that:

— For factors that depend on the biometric system, the biometric system is configured according to the evaluation conditions.

— For factors that depend on the test subject or test subject attributes, that each user has the required testing attribute and testing attribute condition.

— For factors that depend on the interaction process, that test subjects conduct their interactions according to the evaluation conditions.

The test operator may record test subject interactions with the biometric system. This shall be completed in a way that does not impact the test.

7 Requirements for planning a user interaction influence testing of biometric systems

7.1 Test specification

The test design shall specify the following:

a) The objective of user interaction influence testing: to analyse and quantify the effect of one or a set of user interaction influence factors on biometric system performance.

b) A statement that claims the factor(s) and their variation(s) to assess. This shall comply with the evaluation conditions specification.

c) The definition of the REC(s) and TEC(s) to test in accordance with the evaluation condition specifications mentioned in b).

d) The type of the evaluation condition: reference or target.

e) The evaluation conditions specification for enrolment and/or recognition including the factors' specification as well as the necessary equipment and instructions for generating, controlling and recording such specification.

REC and TEC conditions, for both enrolment and recognition, should be presented in a table (see example in Table 4: E — states for enrolment, R — recognition) and organized as follows:

— factors that are not changed across the REC(s) and TEC(s);

— factors that are changed across the REC(s) and TEC(s);

— factors that are not controlled or accounted for in the REC(s) or TEC(s).

Table 4 — Example of TEC and REC conditions

	REC (E)	REC (R)	TEC1 (R)	TEC2 (R)	TEC3 (R)
Device height	0,60 m	0,90 m	1,20 m	1,40 m	1,50 m
Subject training	1 h	1 h	1 h	1 h	1 h
Subject height	Less than 1,80 m	Less than 1,80 m	Less than 1,80 m	Less than 1,80 m	Over 1,80 m
Subject ethnicity	Not controlled	Not controlled	Not controlled	Not controlled	Not controlled

7.2 Test information

For user interaction influence testing, test subjects shall be informed about the evaluation conditions, including what they shall wear during the experiments, such as contact lenses or piercings.

7.3 Test instructions

The test design shall include instructions for test subject presentation of the biometric characteristic(s) to the capture device, including correct and incorrect test subject presentation actions and information given by the device. Test instructions shall include standardized pictograms, icons and symbols according to the ISO/IEC 24779 series.

When assessing factors related to test subject-device interaction during the presentation of a biometric characteristic, instructions shall state how test subjects shall consistently present their biometric characteristic to the device according to its position.

When assessing factors that depend on the users, instructions shall address the physical attributes that test subjects shall possess and any products they shall apply or wear for interaction with the biometric capture device.

When assessing factors that involve translations and rotations during the presentation of a biometric characteristic, the instructions shall explain how the interactions shall be performed. The instructions for each type of interaction shall be provided to test subjects prior to their interaction with the biometric capture device. It is also recommended that a review of the translated phrases and terminology be agreed upon by the test subjects, so as to eliminate any unintended inference based upon potential misunderstanding of translations.

7.4 Testing order of evaluation conditions

The order in which TECs are executed shall be random with the intention of minimizing effects on biometric performance such as habituation and test subject fatigue.

However, user interaction influence testing requires at least two scenario evaluations to be undertaken: one for the REC and another for the TEC. As the number of factors to analyse can be higher, the number of TECs and the scenario evaluations to be carried out can also be higher. As a result, the time and effort needed for the evaluation will increase significantly.

Therefore, careful planning of the execution order of the TECs to test can help to reduce the number of scenario evaluations needed. When there are multiple TECs, they may be executed in a semi-random order. However, this shall be justified. Reasons for a semi-random order can be:

— to minimize the time to change the evaluation configuration,

— to minimize the time of training test subjects,

— according to equipment availability.

When user interaction influence testing entails the evaluation of several biometric systems under the same evaluation conditions, the order of test subject interaction for each system shall be randomized.

7.5 Test results

Results shall be calculated for the user interaction influence testing evaluation. Such results disclose the user interaction influence factor on biometric performance. For this purpose, the evaluator shall report performance for the REC(s) and for each TEC following ISO/IEC 19795-2. Results should be presented in a format that clearly contrasts REC and TEC results for required metrics.

Annex A provides best practices and normative requirements for testing and reporting the user interaction influence of biometric systems.