Usability Evaluation of Biometric Recognition Systems

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1. The need to evaluate HCI in biometrics

**Biometric Evaluations**

- **Performance testing**
  Technical performance: error throughput rates

- **Conformance testing**
  Determine if specific requirements are fulfilled

- **Security testing**
  Security requirements, vulnerabilities, etc.

- **Privacy testing**
  Privacy regulations about personal information

- **Usability testing**
  Users – Biometric system interaction

- ...
1. The need to evaluate HCI in biometrics

Usability Testing

What is Usability?

“The extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specified context of use.” (ISO 9241-11:1998)

Users use final products. Overlook usability may cause misuses and rejection of the technology.

Usability testing and Influence of Usability (or HCI) on Biometrics performance is not the same...
2. Usability and HCI influence on Performance

**Differences**

**Usability Testing**
- Focused on the user
- User satisfaction as main goal
- Widely applied
- Standardized definitions and methodologies:
  - ISO 9241 multi-part standard
  - SQuaRE – CIF
- Not Biometrics-specific

**HCI influence on Performance**
- Focused on the system performance
- Improve results as main goal
- Not widely applied (?)
- Non-standardized definitions or methodologies:
  - Application of definition (ISO 9241)
  - Biometrics-specific
2. Usability and HCI influence on Performance

**Main Works**

**NIST**
- First Works in usability-biometrics
- Several studies based on the ISO 9241
- Huge contribution to standards

**ISO**
- SQuaRE – CIF (25062, 63, 64, 66, etc.)
- ISO 9241 multipart
- SC 37-TR 29156: Usability Considerations
- Not a proper methodology...

**HBSI**
- Usability model based on ISO 9241
- Focused on the FTA
- Great contribution
- Not standardized

**Usability Testing**

**HCI influence on Performance**

**Usability Testing**

**Usability Testing**

**Usability Testing**

**Usability Testing**

-NIST and HBSI as references
- Usability-Performance Methodology
- SC 37 – PNWI in Biometrics - Usability
3. The need of a proper methodology

How to Evaluate

I want to measure the HCI influence on the Biometric system performance...BUT...

• Applying traditional usability testing? Then...what about the influence on performance?
• Applying the ISO/IEC 19795? Then...what about the usability?
• There are several metrics to measure...but how to proceed?
• Several different approaches...How should I start?
4. H-B interaction testing of biometric systems

**Definition**

*H-B interaction testing is a kind of functional test in which a set of users interact with a biometric system(s) with the objective to calculate the accuracy and speed of the recognition algorithms when one or more of the following circumstances occur:*

1. **Characteristics related to the Biometric Capture Device** have been modified.

2. **Human beings or their biometric characteristic** have certain attributes.

3. **Other factors related to the H-B interaction process itself** have been modified.
4. H-B interaction testing of biometric systems

**Definition**

- **Factors** (NIST, 19795-3, HBSI)
  - Human, Biometric system, H-B interaction
- **Metrics** (9241, HBSI, 19795)
- **Evaluation Model** -> Target vs Reference

- **Evaluation Conditions Specification**
  - Definition of Conditions
  - Selection of Conditions
  - Reference and Target Evaluation Conditions
  - Generation and Control of Conditions

- **Fundamental Requirements for:**
  - Planning a HB-i testing
  - Executing a HB-i testing
  - Reporting a HB-i testing

ISO/IEC 19795

-Scenario Evaluation -Online Testing
4. H-B interaction testing of biometric systems

Factors

- Human
  - Behavioral
  - Physical

- System
  - Software
  - Hardware

- Interaction
  - H-B capture
  - H-B system
  - Environment

- Demographics
- Accessibility
- Condition
- Experience
- Interface
- Process
- Ergonomics
- Location

- Type, variations and examples. Many possible changes. Need of constant update

- Presentation
- Guidance
- Training
- Conditions
  ...
4. H-B interaction testing of biometric systems

<table>
<thead>
<tr>
<th>Type</th>
<th>Possible variations</th>
<th>Examples</th>
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<tbody>
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<td>Anthropometric data</td>
<td>Body dimensions</td>
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<td>Physical features</td>
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<td>Occupation</td>
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<td>Interaction-influential</td>
<td>Fixed</td>
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<tr>
<td>Accessibility concerns</td>
<td>Temporal</td>
<td>Long term</td>
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<td>Short term</td>
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</table>
### Metrics

**Interaction metrics**

| HBSI | ISO 9241 |

**Performance related metrics**

| HBSI | ISO/IEC 19795 |

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<table>
<thead>
<tr>
<th><strong>Type</strong></th>
<th><strong>Variables</strong></th>
<th><strong>Definition</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usability</strong></td>
<td>Effectiveness</td>
<td>Errors, assistance actions, tasks completion</td>
</tr>
<tr>
<td></td>
<td>Efficiency</td>
<td>Time spent in the processes</td>
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<td></td>
<td>Satisfaction</td>
<td>Degree of users satisfaction</td>
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<td></td>
<td>Learnability</td>
<td>User who learnt how to use the system</td>
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<td></td>
<td>Memorability</td>
<td>User who remember how to use the system</td>
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<td></td>
<td>User Acceptance</td>
<td>Willingness to use the system</td>
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<td><strong>Accessibility</strong></td>
<td><strong>Physical</strong></td>
<td>Subjects that can use the system</td>
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<td></td>
<td><strong>Cognitive</strong></td>
<td>Subjects that know how to use the system</td>
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<td><strong>Signal Processing</strong></td>
<td><strong>Biometric sample</strong></td>
<td>Quality metrics</td>
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<td>Time to capture</td>
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<td>Number of segmentation errors</td>
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<td>Number of features extraction errors</td>
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<td></td>
<td></td>
<td>Segmentation time</td>
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<tr>
<td></td>
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<td>Features extraction time</td>
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</tbody>
</table>

**Traditional metrics. Error rates and Throughput rates**

- HBSI interaction metrics*
- Erroneous presentation: DI, CI, FI
- Correct presentation: FTD, FTP, SPS

*Continuously updated
HB-i Factor

“any characteristic, feature, property or condition of human beings, biometric systems or their interaction processes that may influence on biometric system performance”

Factor specification

“detailed description of the design, feature, property or condition of a specific H-B interaction factor”

This description defines the factor and its possible variation unequivocally. Depending on the type of evaluation condition the specification can be:

- A reference specification. This is the factor specification established for reference evaluation conditions.
- A target specification. This is the factor specification defined for target evaluation conditions.
4. H-B interaction testing of biometric systems

Definitions

Evaluation conditions

“each of the conditions which involve a different H-B interaction circumstance and which are tested for analysing their influence on biometric system performance”

- **Reference evaluation conditions (REC).** These evaluation conditions entail the analysis of a reference specification for the H-B interaction factor(s) under test. For these conditions the biometric system is analysed to obtain baseline performance metrics for making comparisons.

- **Target evaluation conditions (TEC).** These evaluation conditions involve the analysis of the target specification for the H-B interaction factor under test. For these conditions the biometric system is analysed to obtain performance metrics for studying the influence of one or more H-B interaction factor(s), by comparing with the results obtained at the REC.

Parties involved

“entities or organizations (the test laboratory conducting the evaluation and the developer or customer who requests the evaluation) interested in the evaluation and have responsibilities in the evaluation process.”
4. H-B interaction testing of biometric systems

1. Test subjects interact with the biometric system.
2. Biometric system recognition outcomes and the test subjects' interactions are recorded.
3. Then, it is possible to determine the biometric system performance in addition to HCI metrics for the specific evaluation conditions.
4. The comparison between results of REC and TEC shows whether the biometric system is influenced by the analysed H-B interaction factor, as well as quantifies this influence.
Definition of the evaluation conditions: determining which H-B interaction factors will be assessed during the experiments

- Factors depending on the biometric capture device
- Factors depending on human beings
- Factors depending on human-system interaction

Selection of the evaluation conditions: determining which H-B interaction factors will be assessed during the experiments

- Shall be done by the parties involved in the evaluation.
- This decision should be based on several parameters: the biometric modality of the system under test, the type of technology used by its capture device, the target application, as well as the target population (refer to ISO/IEC TR 19795-3 which lists factors that can impact biometric performance for the most relevant modalities).
### Reference Evaluation Conditions (REC)

**Enrollment**

Conventional conditions when the operational conditions are similar for enrolment and recognition processes, or values according to the real enrolment conditions when the enrolment is executed in particular controlled conditions. **Not Always covered by HB-i.**

**Recognition**

The reference specification for recognition evaluation conditions shall be **identical to the enrolment evaluation conditions** except when enrolment is carried out in particular controlled conditions.

### Target Evaluation Conditions (TEC)

**Enrollment**

When the purpose of the evaluation includes the comparison of the enrolment process for a specification of factors **different from the reference specification**.

**Recognition**

Shall be selected by **parties involved** in the evaluation according to the particular factors and their possible variations that are going to be tested.
Generation of the evaluation conditions: For conducting the scenario evaluation in each evaluation condition, the specification of the relevant factors shall be satisfied.

- **For factors that depend on the biometric capture device** it is essential to prepare the system as indicated. It may require the usage of a proper structure which models the desired locations.

- **For factors that depend on the human beings** it is necessary to provide the test subjects with the corresponding physical element or chemical product and explain them how to proceed. In some cases it is not possible to provide a particular element (e.g. piercings), so test subjects composing the test crew shall be selected according to the defined characteristics.

- **For factors that depend on the interaction process** it is necessary to develop guidelines for instructing test subjects about how they must present their biometric characteristics to the biometric capture device in compliance with the evaluation conditions specifications.
Control of the evaluation conditions: it is required to control exhaustively that test subjects proceed according to the evaluation conditions.

- **For factors that depend on the biometric capture device** test operators shall check that the biometric capture device is placed as it has been specified for the evaluation conditions which have been tested at that moment.

- **For factors that depend on the human beings** operators shall check that users are proceeding properly. It depends on the exact evaluation conditions to test.

- **For factors that depend on the interaction process** it is necessary to develop guidelines for instructing test subjects on how to present their biometric characteristics to the biometric capture device in compliance with the evaluation conditions specifications.
4. H-B interaction testing of biometric systems

**Requirements**

**Fundamental Requirements for**

**PLANNING**
- Define evaluation objectives
- Operational environment
- Test crew
- Level of effort
- Test procedures and execution sequence
- Error protocols
- Data to record and results

**EXECUTING**
- Pre-test activities
- Test activities (visit 1, 2,...)
- Post-test activities

**REPORTING**
- Test plan
- Modifications
- Final test crew
- Description of particular factors specification that has been tested.
- Specific evaluation configurations for each evaluation (e.g. diagrams)
- Test results
- Errors during the experiments.
- Any relevant comment on error logs.
- The baseline performance results.
- General results and analysis
- Final conclusions

**per condition**
Conclusions

5. H-B interaction testing of biometric systems

A new proposal for assessing HCI influence on biometric systems performance

Further inputs from Usability Testing may be considered

Currently in PNWI state within the ISO/IEC/JTC1/SC37/WG5

Open for comments and contributions
Usability Evaluation of Biometric Recognition Systems

Thank you for your attention

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Common Criteria provides assurance that the process of specification, implementation and evaluation of a computer security product has been conducted in a rigorous and standard and repeatable manner at a level that is commensurate with the target environment for use.

**Target Of Evaluation (TOE):** The TOE is the IT product, or the part of an IT product, or the set of IT products that is going to be assessed considering only the selected configuration/s to be tested.

**H-B-i**

Isolate usability factors to properly measuring their influence in biometrics performance

**Targeting factors TOEs**
Usability/UX/HCI

UX starts by being **useful**.

Functionality, people **must** be able to use it.

The way it **looks** and **feels** must be **pleasing**.

This helps create an overall **brand experience**.

**Brand Experience**

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**Desirability**

**Usability**

**Utility**

It is useful to me.

It meets my needs.

I am able to use the product easily.

I like the way the product looks and feels.

My overall feeling about the brand/product (in the abstract) is good.

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Source: User Experience 2008, nnGroup Conference Amsterdam

Retrieved from: http://neospot.se/usability-vs-user-experience/
# Usability standards

## Principles and recommendations

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<tr>
<th>Use in context</th>
<th>Specifications</th>
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<tr>
<td>ISO 9241: Ergonomic requirements for office work with visual display terminals, Parts 10-17</td>
<td>ISO/IEC 11581: Icon symbols and functions</td>
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<tr>
<td>ISO 11064: Ergonomic design of control centres</td>
<td>ISO 13406: Ergonomic requirements for work with visual displays based on flat panels</td>
</tr>
<tr>
<td>ISO 14915: Software ergonomics for multimedia user interfaces</td>
<td>ISO/IEC 14754: Pen-based interfaces - Common Gestures for text editing with pen-based systems</td>
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<tr>
<td>IEC TR 61907: Guidelines for the user interfaces in multimedia equipment for general purpose use</td>
<td>ISO/IEC 18021: Information Technology - User interface for mobile tools</td>
</tr>
<tr>
<td>ISO 18789: Ergonomic requirements and measurement techniques for electronic visual displays</td>
<td>ISO/IEC 19788: Information Technology - User interface for computer displays</td>
</tr>
</tbody>
</table>

## Specifications

<table>
<thead>
<tr>
<th>Documentation</th>
<th>Development process</th>
<th>Capability</th>
<th>Other</th>
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<tbody>
<tr>
<td>ISO/IEC 18019: Guidelines for the design and preparation of software user documentation</td>
<td>ISO TR 16992: Usability methods supporting human-centred design</td>
<td>ISO 19075-1: Ergonomic principles related to mental workload - General terms and definitions</td>
<td>ISO TR 18524: Guideline on task requirements</td>
</tr>
</tbody>
</table>

**ISO/IEC 25062:2006:** Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability test reports  
**ISO/IEC TR 25060:2010:** Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: General framework for usability-related information  
**ISO/IEC 25063:2014:** Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: Context of use description  
**ISO/IEC 25064:2013:** Systems and software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: User needs report