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Information technology — Biometrics — Evaluation of examiner assisted biometric applications

Technologies de l'information — Biométrie — Évaluation des applications biométriques assistées par un examinateur

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Contents

Page

Foreword

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The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

Introduction

Biometric identification systems such as those used in forensic applications are typically examiner assisted and not automated to the extent that most biometric systems are. This is particularly the case for applications such as latent fingerprint searching where sample quality can be so poor that the system requires human input. Key processes such as sample capture and preparation, enrolment, template generation, matching result adjudication, and final decision that would otherwise require minimal manual intervention are instead heavily reliant on input from experts (fingerprint examiners in the case of AFIS). These experts can interact with the system at each of these stages to prepare, launch, and/or review the results of biometric searches. The execution and performance of the "end-to-end" search process is thus, a combination of the examiner's role (and capability) and the functionality of the automated biometric system.

This partially automated approach to biometrics using "*examiner assisted*" biometric systems provides value both in assisting the human examiner to perform their role more effectively, and in allowing the expertise of the human examiner to be exploited to assist the automated matching process. Therefore, such systems are most likely to be beneficial in non-real time scenarios where the search response is not necessarily required immediately but the throughput of the system is still high.

Understanding the role of the examiner is crucial, as it impacts on the design of the system, the manner in which it is used, how it is tested, and how the system performance and its individual subcomponents are defined and measured.

The main objectives of this Technical Report are to describe the characteristics of *examiner assisted* biometric applications and, where appropriate, to contrast such applications with mainstream biometric applications.

This Technical Report addresses the issues with assessing the system as a whole, or by testing the *examiner assisted* and automated elements separately.

Information technology — Biometrics — Evaluation of examiner assisted biometric applications

1 Scope

The purpose of this Technical Report is to identify and characterize those aspects of performance testing that are unique to examiner assisted biometric applications.

An examiner assisted biometric system has the following characteristics:

— reliant on the interaction and skill of a human examiner for one or more stages of the complete biometric process, be it data capture, enrolment, template generation, or final decision;

— can incorporate identification functionality, verification functionality, or both;

— will use a combination of the examiner's input and the functionality of the biometric algorithm to execute the complete biometric process;

— will likely have inbuilt examination toolsets to assist the human examiner when enrolling biometric samples or when comparing the match results provided by the biometric algorithm.

Although there is a wide variation in the use of the term "examiner" in the context of an "examiner assisted biometric system", as defined in this Technical Report, an "examiner" typically has the following characteristics:

— field expert in the biometric modality being exploited;

— trained to use the system to an advanced degree of proficiency;

— authorized to override the biometric system's decisions in particular when accepting or rejecting a match decision based on their own examination of the biometric samples and the results returned.

Assessing an examiner's level of expertise is excluded from the scope of this Technical Report. However, the skill of the examiner does have a major bearing on system performance and vice versa. Measuring or assessing the ability of an examiner to employ their skills might be necessary to properly evaluate the performance of an examiner-assisted system.

Other individuals, such as administrative users, or subjects whose biometrics are used within the system are not considered in this Technical Report. It is outside the scope of this Technical Report to consider non-expert examiners.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
examiner
person responsible for examining biometric data and biometric system outputs for the purpose of either preparing data suitable for a system or confirming, overriding, or modifying a decision output from the biometric system

Note 1 to entry: This decision output could be a match decision or simply the location of a biometric feature point (e.g. a fingerprint core and delta points, or the location of eye co-ordinates on a facial image).

2.2
examiner assisted
feature or quality of a process, application, system, or any other element that refers to the fact that an examiner takes part by contributing his/her knowledge and expertise

2.3
suspected match
decision state indicating qualified support on the part of an examiner that a match exists, based on the outcome of the examination process and on the limitations of the relevant comparable data

2.4
suspected non match
decision state indicating qualified support on the part of an examiner that no match exists, based on the outcome of the examination process and on the limitations of the relevant comparable data

3 Symbols and abbreviated terms

AFIS Automated Fingerprint Identification System

4 Example of an examiner assisted search process

Consider the diagram below in Figure 1 which illustrates at a very high level, some of the basic stages of a biometric search process. With the exception of the "search" which is fully automated, all other processes are potentially assisted by the interaction of a human examiner. Figure 2 shows each of the examiner assisted points in a diagram representing a generic biometric application.

Figure 1 — Basic stages of a biometric search process

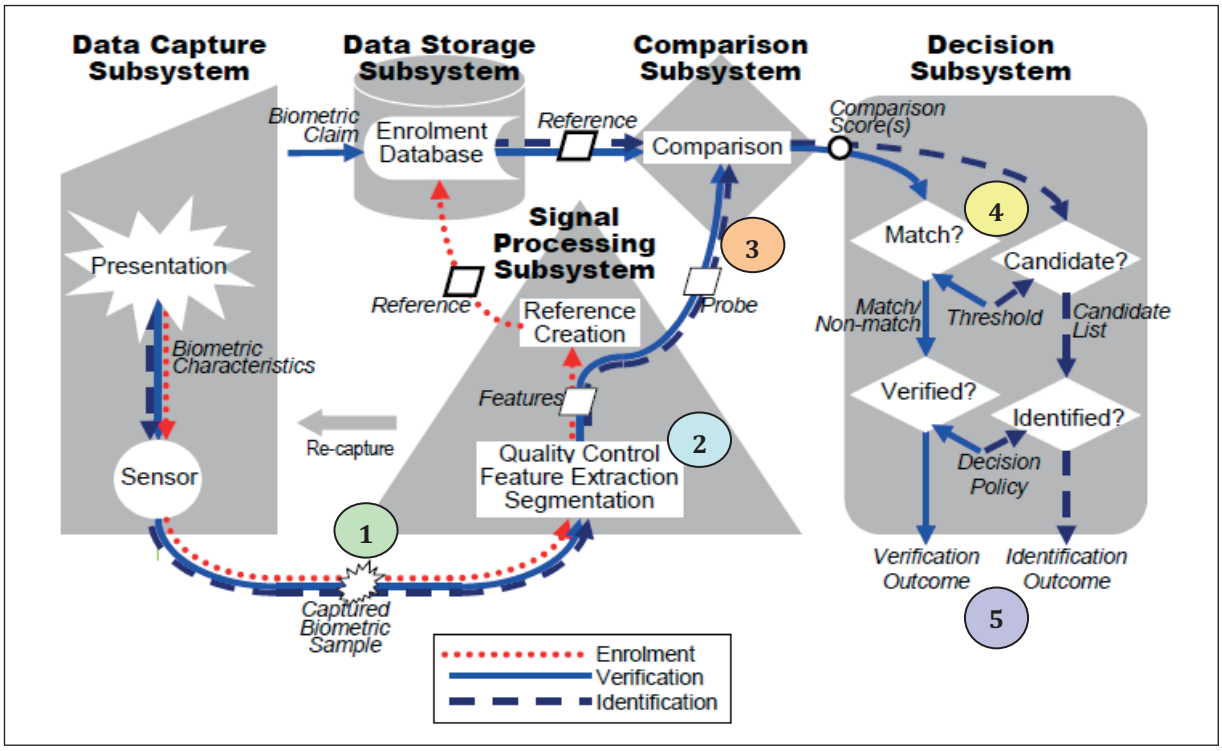

Figure 2 — A generic biometric application highlighted to indicate the examiner assisted points

To illustrate the importance of the examiner assisted stages, consider the role of forensic AFIS examiners. These are fingerprint experts, trained specifically to interact with the system, to fully exploit the functionality of the AFIS in order to prepare, launch, and review the results of the biometric searches. Their interaction at each of these examiner assisted stages shown in Figure 1 can be described as follows.

a) **Capture:** An image is scanned by an examiner or imported directly into the system. If multiple images are available the examiner may select the image(s) that they consider as (the most) suitable quality for searching.

b) **Edit and Encode:** The image is displayed for viewing on a monitor and may be enhanced or edited by the examiner to improve the visibility, and subsequent placement, of features by an examiner. User interface tools are provided to enable the examiner to manually encode features such as fingerprint minutiae, cores, deltas, etc. The examiner may also *override* system decisions about the placement of features such as minutiae, based on their skill and expertise. Some systems may iterate this process to gradually improve the quality of the data with each cycle of manual and automated processing.

c) **Search Parameters:** The examiner may specify search parameters to provide additional data to the matcher in order to maximise likelihood of the search resulting in a match if one exists in the database. Finger position, palm region, orientation, or pattern type may typically be input by the examiner following careful study of the biometric data being searched, based on their domain specific knowledge.

d) **Responses:** The matcher threshold may be manually configurable in order to adjust the number of responses returned. Alternatively, the desired number of responses may be configurable directly, within some system-defined bounds. Some searches may be assigned a certain level of priority (over other searches) depending on the importance of the search outcome. An example of this may be a search conducted on a police system relating to a serious crime.

e) **Decision:** When the output of the search is returned (typically as a ranked list of potential matches when used in a forensic context) the examiner compares the enquiry and respondent images in order to accept or reject possible matches. Even at this stage certain tools on the user interface may be utilised to assist the examiner in performing this comparison. In some cases the examiner may not be able to

make an acceptance or rejection decision and may either deem the result indeterminate or return to the edit and encoding step to initiate an augmented search. Such practice should be documented.

At stages 1 through 3, the aim is to provide additional information to the system that cannot be derived automatically. In the case of forensic AFIS the fingerprint data submitted for searching is generally of poor quality, highly varied and thus requires the input of the examiner in order to be able to accurately search the database. Therefore, the value of an examiner interacting with the system is the direct impact that their actions have on performance, especially where data quality is severely compromised.

Although forensic AFIS has been chosen as an example, a wide variety of biometric systems or applications could involve examiner interaction.

The following list provides some examples:

— AFIS — fingerprint matching system, typically using full ten-print enrolments and usually full 10-print probes, often very large scale. Human role is usually to perform a final match/non match decision from a candidate list

— Forensic AFIS — semi-automated fingerprint matching application, often using 10-print enrolments. The human role is to mark-up the latent print and make a final match/non match decision.

— Facial recognition — alias or duplicate enrolment detection. The human role is to perform a final match/non match decision from a candidate list (applications such as visa programs, drivers licences)

— Physical Access Control — a security guard making a human decision of facial match/non match — for example using printed face on ID card/passport — as part of a secondary check or a back-up process in the event of the biometric comparison resulting in a reject decision.

— Adjudication processes — Any decision output from a biometric system that is one of ‘Match’, ‘Non match’, ’Uncertain’ or ‘Suspected Match’, and where all “uncertain” and “suspected” instances are brought to the attention of a trained human agent to resolve, or will be left in the system in the suspected state in anticipation that new biometric or other data, or advances in technologies or changes in policy will allow a resolution of the match.

— Enrolment Quality Checks — a decision, made by a human (possibly aided by automated tools) following a check to determine if the quality of an enrolment sample(s) is of sufficient quality to accept, or if the subject needs to retry enrolment.

Forensic AFIS applications (used for latent searching) are reliant on the interaction of a fingerprint expert at each stage of the complete biometric process. This serves as a good example of an examiner assisted system as it is well defined or understood in comparison to other examiner assisted applications. Therefore, it will be used to illustrate many of the points made in this report.

NOTE To demonstrate the contrast of a forensic AFIS system from that of a standard AFIS consider the scenario of a (*civilian*) fingerprint system being used for checking identity documents at a point of exit or entry. The operator of the system might be involved at a number of stages in the overall system functionality — for example, to assist subjects during the enrolment, or to manually oversee subjects pass through an entry/exit point controlled by the system. However, the operator in this instance would not be an expert, or be required to examine the biometric data at the time; rather their actions would be prompted by the output of the system. It is outside the scope of this technical report to consider such (non-expert) operators or indeed all other users or administrators.

5 Factors to consider when evaluating examiner assisted biometric applications

5.1 General

Any sound evaluation should begin with a thorough examination of the context in which the biometric system is operating, as well as the business processes underlying its use. Such an assessment is generally qualitative in nature, and may consist of interviews or process mapping tools aimed at gaining a sound understanding of current processes and procedures.

There are a number of factors to consider when evaluating examiner assisted biometric applications, and their relative importance varies with application. At each stage where an examiner is involved with the system, the test design must consider whether this interaction should be specifically addressed or accounted for in the test. It is beyond the scope of this technical report to make specific recommendations; however, this technical report will highlight some points to consider when evaluating such systems. Broadly speaking these considerations can be categorised as 'system-related' or 'examiner-related' factors.

5.2 System-related factors to consider when evaluating examiner assisted biometric applications

5.2.1 Dependencies in the flow process — Where does the examiner interact with the system?

Examiner interaction with the system, at any stage, may have an effect on overall processes and performance. Decisions made at one stage may also have implications for the level of interaction required by the examiner at subsequent stages. Ultimately, there is a trade-off between increasing reliance on an examiner, either in part or across the whole end to end process, against the benefits to performance overall.

The *Edit* and *Encode* process, described earlier in Clause 4, is an example of this. An examiner may be required to spend more time editing and encoding an image to pre-process the search for the matcher to perform better; thereby reducing the time required by the examiner to visually examine images at the decision stage. Alternatively, a system may be designed to minimise the amount of time allocated for pre-processing the search, with greater reliance placed on visual examination of search results.

Therefore, evaluations that measure the performance of examiner assisted biometric applications should take these interdependencies within the overall process into account in order to understand is there is merit in changing the level of reliance on an examiner at any stage of the process.

The test design should attempt to identify and quantify the level of impact that the examiner's actions have on the performance of the system. However, simply removing the examiner from the process may not be feasible or desirable, and where appropriate it may be better to impose controls around what the examiner can do at particular stages in order to isolate and understand the impact of their actions on subsequent stages.

For example in 5.2.2 below the concept of system and stage-level performance is introduced to decompose the overall process into stages that are automated (partially or fully) and those that are entirely reliant on the examiner.

5.2.2 System and stage-level performance measurement

5.2.2.1 Introduction

In order to clearly understand the contribution/impact of human input/interaction in the overall biometric process, it is necessary to decompose the overall process into individually measurable stages. Then when taken collectively, the overall system-level performance can also be computed. The differences between 1:1 verification and 1:N identification systems dictate that different performance measures be described for these two categories. Furthermore, there is a need to describe specific performance measures for the different automated and examiner assisted stages. The decision matrices described in the following sections provide examples of determining system and stage-level performance to assess the stage where the final match decision is made, or overridden, by a human examiner.

In the following tables, green cells indicate correct decisions, and red cells indicate incorrect decisions.

Identification application with human examiner input at the final decision stage only The following describes the means of defining and computing performance at each stage of an identification application where the final match/non match decision is made by a human reviewing a candidate list of potential matches.

There are 5 possible outcomes for the automated stage where a candidate list is generated and for which a true mate biometric reference sample is either previously enrolled (mated) or not enrolled (non-mated) on the system. See the Table 1 below for details.