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Information technology — Biometric calibration, augmentation and fusion data —

Part 1: Fusion information format

Technologies de l'information — Étalonnage biométrique, données d'augmentation et de fusion —
Partie 1: Format d'information de fusion

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO/IEC 29159-1 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

ISO/IEC 29159 consists of the following parts, under the general title *Information technology — Biometric calibration, augmentation and fusion data*:

— *Fusion information format*

Introduction

Biometric systems embed disparate technologies and comparison algorithms. Although some of these have been published, most are entirely proprietary. Most current verification or identification applications employ a single biometric modality. That is, information is acquired from a body part or an exhibited behavior with the intent of more or less uniquely identifying the individual. For example, an access control system can image the hand and use geometrical features. A social benefits program can collect fingerprints from applicants as input to a one-to-many duplicate search. Different biometric modes offer varying amounts of discriminative information and have different acquisition related problems. The effect is that biometric systems are to some extent fallible and, moreover, they exhibit different failure modes. This affords opportunities to combine technologies or algorithms to improve performance and/or usability. Such combination is known as fusion. Fusion can be multi-modal (e.g. observing the biometric characteristics, face and finger), multi-algorithmic (e.g. face recognition algorithms A and B), multi-instance (e.g. index finger and thumb), multi-sensorial (e.g. optical and ultrasound fingerprint sensor) or multi-presentation (e.g. three images of a user's face).

This part of ISO/IEC 29159 addresses the most common and most readily implemented method of fusion: score-level fusion. This is implemented after two or more systems have processed and matched an individual's biometric information to one or more enrolled samples and produced scalar comparison scores as output. The scores can be either genuine (same-person) or impostor (different-person) scores and a fusion scheme is designed to combine such scores so that the class boundary between genuine and impostor scores is refined.

Distributions of comparison scores are unique to each biometric comparison subsystem. Score ranges and the shapes of the distributions can differ greatly. Fusion is often implemented in two ways.

— In classification-based processes, the available comparison scores are combined directly to produce an output decision or score.

— In normalization-based processes, fusion is preceded by a transformation of each score to a common domain. Simple normalization techniques based on statistical parameters such as the mean and standard deviation are sometimes effective, but more sophisticated techniques utilize detailed knowledge of the entire score distribution. The fusion information format (FIF) defined in this part of ISO/IEC 29159 is intended to flexibly support any of the popular transformations. By establishing a standardized means of data exchange, this part of ISO/IEC 29159 supports a modular approach to biometric systems integration in which both the comparison and fusion algorithms remain protected as black-box pieces of intellectual property. Thus this part of ISO/IEC 29159 envisages an application in which two (or more) underlying acquisition and comparison technologies (hand geometry and fingerprint, for example) each generate a score which is fed to a fusion module which has been initialized with an appropriate instance of the FIF defined herein.

Figure 1 depicts the logical role of the records in a (notional) multimodal fusion process.

This part of ISO/IEC 29159 defines containers for the distributional score information from a comparison subsystem. It does not allow for joint distributional data that can fully capture the statistical properties of multivariate scores (i.e. those from two or more vendors' subsystems or modalities). This means that multimodal fusion is not supported by a description of the joint distributions of the biometric scores. This is often a minor limitation because different modalities are often assumed to be independent. Even when the scores are not independent, as is the case for multi-algorithm applications, score-level fusion techniques often remain effective, even if they are not optimal.

This part of ISO/IEC 29159 is intended to support interoperability and data interchange among biometrics applications and systems. As such it specifies requirements that solve the complexities of applying biometrics to a wide variety of personal recognition applications, whether such applications operate in an open systems environment or consist of a single, closed system. Open systems are built on standards based, publicly defined data formats, interfaces, and protocols to facilitate data interchange and interoperability with other

systems, which can include components of different design or manufacture. A closed system can also be built on publicly defined standards, and can include components of different design or manufacture, but inherently has no requirement for data interchange and interoperability with any other system.

Biometric data interchange format standards and biometric interface standards are both necessary to achieve full data interchange and interoperability for biometric recognition in an open systems environment. The biometric International Standards developed within JTC 1/SC 37 form a layered set of International Standards consisting of biometric data interchange formats and biometric interfaces, as well as application profiles that describe the use of these International Standards in specific application areas.

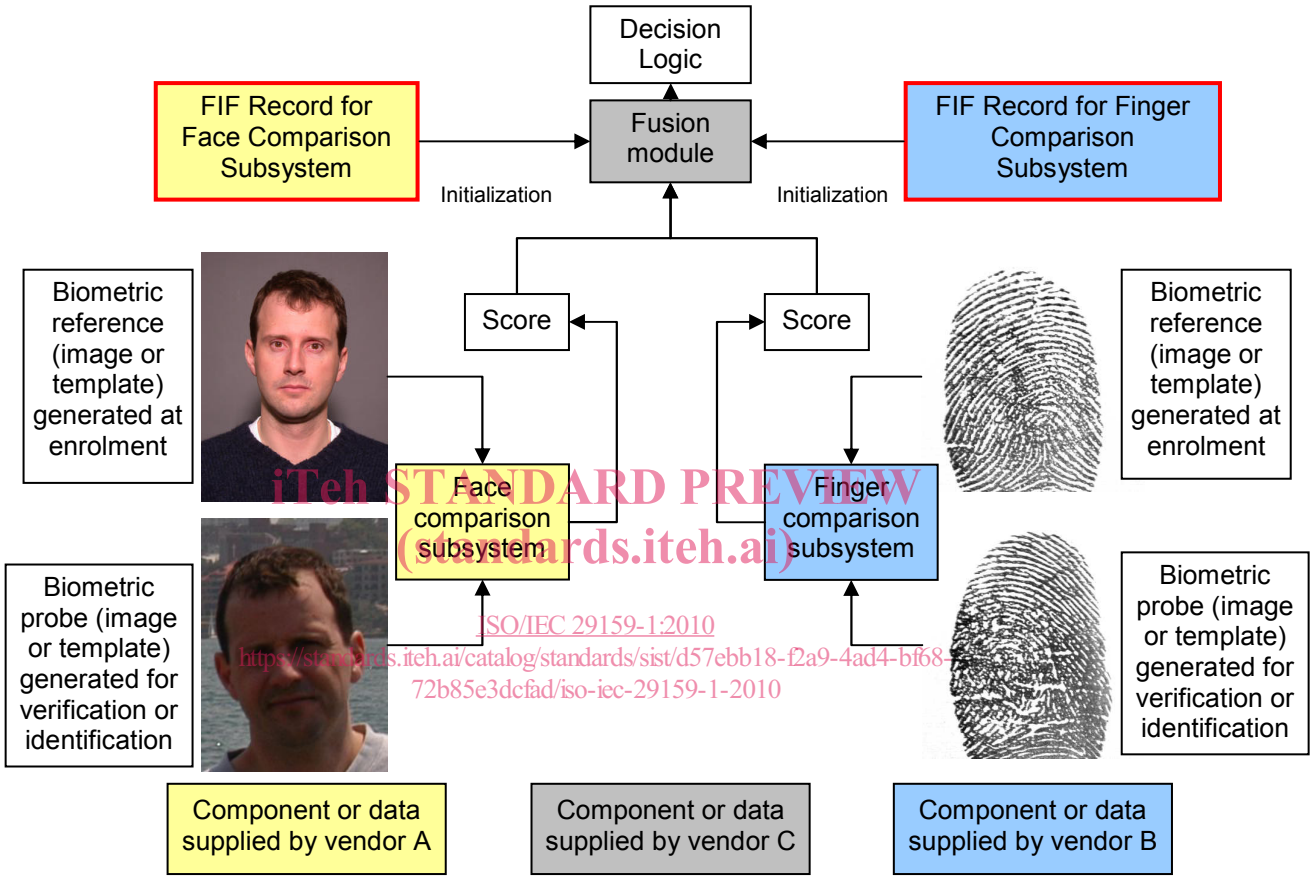

Figure 1 — Schematic representation of fusion information format usage

Information technology — Biometric calibration, augmentation and fusion data —

Part 1:
Fusion information format

1 Scope

This part of ISO/IEC 29159 specifies a biometric fusion information format that establishes machine readable data formats to describe the statistics of comparison score inputs to a fusion process.

This part of ISO/IEC 29159 does not

— standardize comparison-score normalization processes, nor

— standardize or define fusion processes.

2 Conformance

Records are conformant to this part of ISO/IEC 29159 if they conform to all normative requirements of Clause 6. This requires conformance to either Clause 8, 9, or 10, each of which requires conformance to the stated subclauses of Clause 7.

3 Normative references

The following referenced documents are indispensable for the application 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.

IEEE 754-2008, *IEEE Standard for Floating-Point Arithmetic*

ISO/IEC 19785-1:2006, *Information technology — Common Biometric Exchange Formats Framework — Part 1: Data element specification*

ISO/IEC 19794-1:2006, *Information technology — Biometric data interchange formats — Part 1: Framework*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19794-1 and the following apply.

4.1
biometric sample
analog or digital representation of biometric characteristics prior to biometric feature extraction

NOTE A biometric capture device is a biometric capture subsystem with a single component.

4.2
cumulative distribution function
probability that a variate takes on a value less than or equal to a number

4.3
genuine score
comparison score from comparison of two samples from one person

4.4
impostor score
comparison score from comparison of two samples from different persons

4.5
location parameter
generic measure of the position of a distribution

NOTE The location parameter is not necessarily the mean of a distribution.

4.6
probability density function
derivative of the cumulative distribution function

4.7
scale parameter
generic measure of the breadth of a distribution

NOTE The scale parameter is generally not the variance (nor the standard deviation) of a distribution.

4.8
comparison score
scalar output from biometric comparison subsystem

NOTE The term comparison score is used generically in this part of ISO/IEC 29159 for both distances (smaller indicates greater likelihood that samples come from same person) and similarity scores (higher indicates same-person). This distinction is conveyed explicitly in the score sense type defined in 6.4.9.

5 Symbols and abbreviated terms

For the purposes of this document, the following abbreviations apply. In tables that define binary record structures the use of the symbol "M" in the status column indicates that the field itself is mandatory. A value of "O" indicates the field is optional. This means that the bytes for the fields might not be present. In all cases records can be parsed because the presence or absence of an optional field is recorded in a preceding field.

CBEFF	Common Biometric Exchange Formats Framework
CDF	cumulative distribution function
ECDF	empirical cumulative distribution function
FAR	false accept rate
FMR	false match rate
FIF	fusion information format
PDF	probability density function
ID	identifier

6 Fusion information format (FIF)

6.1 Overview

6.1.1 Record structure

The FIF record is used to support modularity in multi-modal biometric and decision support systems. Its format is given in Table 1.

NOTE An application should establish a profile of part of the ISO/IEC 29159 standard. A default profile would explicitly call out one of the record types.

Table 1 — Fusion information format record structure

Fusion header block	Type 1 Record (see clause 6.1.3)	and/ or	Type 2 Record (see clause 6.1.4)	and/o r	Type 3 Record (see clause 6.1.5)

6.1.2 Header structure

The fusion header block structure defines the format of the record, and indicates the content. Its format is given in Table 2.

Table 2 — Fusion header block structure

Fusion header block	=	Format Identifier	Version Number	Record Length	Biometric Type
clause 6.4		6.4.2	6.4.3	6.4.4	6.4.5
25 bytes		4	4	4	3

row continuation	Comparison Subsystem Product ID	Database ID	Enrolment Database quality	Verification Database quality	Score Sense	Number of Type Instances
	6.4.6	6.4.7	6.4.8	6.4.8	6.4.9	6.4.10
	4	2	1	1	1	1

6.1.3 Type 1 record structure

The fusion header block structure defines the format of the record, and indicates the content. Its format is given in Table 3.

Table 3 — Type 1 record structure

Type 1 Record Structure	=	Type	Distributions Present	Impostor Distribution			Genuine Distribution		
				Num Comp	Loc	Scale	Num Comp	Loc	Scale
clause 8.2		8.2.3	8.2.4	8.2.5	8.2.6	8.2.7	8.2.8	8.2.9	8.2.10
26 or 50 bytes		1	1	4	10	10	4	10	10

6.1.4 Type 2 record structure

The fusion header block structure defines the format of the record, and indicates the content. Its format is given in Table 4.

Table 4 — Type 2 record structure

Type 2 Record Structure	=	Type	Distributions Present	Impostor Distribution CDF	Genuine Distribution CDF
clause 9.2		9.2.3	9.2.4	9.2.5	9.2.6
16N+13 or 32N+22 bytes		1	1	16N+11	16N+11

6.1.5 Type 3 record structure

The fusion header block structure defines the format of the record, and indicates the content. Its format is given in Table 5.

Table 5 — Type 3 record structure

Type 3 Record Structure	=	Type	Distributions Present	Impostor Distribution CDF	Genuine Distribution CDF
clause 10.2		10.2.3	10.2.4	10.2.5	10.2.6
16N-18 or 32N-38 bytes		1	1	16N-20	16N-20

6.2 Byte ordering

Within the FIF record, and all well-defined data blocks therein, all multi-byte quantities shall be stored in Big Endian format. That is, the more significant bytes of any multi-byte quantity are stored at lower addresses in memory than the less significant bytes.

EXAMPLE For example, the value 1025 (2 to the 10th power plus one) would be stored as first byte= 00000100b and second byte=00000001b.

6.3 Numeric values

All numeric values present in the defined Types of this part of ISO/IEC 29159 are fixed-length unsigned integer quantities, unless specified otherwise.

All numeric values given in the text of this part of ISO/IEC 29159 are decimals, unless preceded by 0x, to indicate hexadecimal, or suffixed by a "b" to indicate binary.

Table 6 — Textual representation of numerical value

Example value	Radix	Decimal value
1010b	2	10
39	10	39
0xF5	16	245

Double precision numbers shall be conformant with IEEE 754.

NOTE The specification of IEEE 754 may not be sufficient to avoid numerical inaccuracy.

6.4 Fusion header block

6.4.1 General

The fusion header block of Table 7 shall be present as the first block in all FIF records.