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Information technology — Extensible biometric data interchange formats —

Part 2:
Finger minutiae data

ICS: 35.240.15

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

A list of all parts in the ISO/IEC 39794 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Biometric data interchange formats enable the interoperability of different biometric systems. The first generation of biometric data interchange formats has been published between 2005 and 2007 in the first edition of the multi-part standard ISO/IEC 19794. From 2011 onwards, the second generation of biometric data interchange formats has been published in the second edition of the established parts and the first edition of some new parts of ISO/IEC 19794. In the second generation of biometric data interchange formats, new useful data elements such as data elements related to biometric sample quality have been added, the header data structures have been harmonized across all parts of ISO/IEC 19794, and an XML encoding has been added in addition to the binary encoding.

In anticipation of the future need for additional data elements and to avoid future compatibility issues, ISO/IEC JTC 1/SC 37 has developed ISO/IEC 39794 as third generation of biometric data interchange formats, defining extensible biometric data interchange formats capable of including future extensions in a defined way. Extensible specifications in ASN.1 (Abstract Syntax Notation One) and the Distinguished Encoding Rules of ASN.1 form the basis for encoding biometric data in binary tag-length-value formats. XML Schema Definitions form the basis for encoding biometric data in XML (Extensible Markup Language).

This third generation of finger minutia data interchange formats complements the standard ISO/IEC 19794-2:2005 and ISO/IEC 19794-2:2011. The first generation of biometric data interchange formats, which has been adopted in mass deployments, will be retained in the standards catalogue as long as required.

This part of ISO/IEC 39794 is intended for those applications requiring the exchange of fingerprint minutiae data. It will provide implementers with the flexibility to accommodate minutiae captured from dissimilar devices, varying image sizes, spatial sampling rates, and different grey-scale depths. Use of the finger minutiae will allow each vendor to implement their own algorithms to determine whether two fingerprint records are from the same finger.

This part of ISO/IEC 39794 supports both binary and XML encoding, to support a spectrum of user requirements. With XML, this part meets the requirements of modern IT architectures. With binary encoding this part is also able to be used in bandwidth or storage constrained environments.

For use on integrated circuit cards and other tokens (see ISO/IEC ISO/IEC 7816-11 and ISO/IEC 24787), this document also specifies an on-card biometric comparison format and on-card comparison parameters based on extensible TLV encoding. ISO/IEC 24787 specifies the encapsulation of biometric data in on-card biometric comparison format into TLV-structured verification data for on-card biometric comparison.

This part of ISO/IEC 39794 defines specifics of the extraction of key points (called minutiae) from fingerprint ridge patterns. These specifics include a description of the types of minutiae identified, the method used for the placement of minutiae on an image, a definition of the coordinate system used, and the methods used to calculate the angle associated with each minutia.

Information technology — Extensible biometric data interchange formats — Part 2: Finger minutiae data

1 Scope

This part of ISO/IEC 39794 specifies

— generic extensible data interchange formats for the representation of finger minutia data:

  - a tagged binary data format based on an extensible specification in ASN.1
  - a textual data format based on an XML schema definition that is capable of holding the same information as the tagged binary format, and
  - an on-card biometric comparison format based on extensible TLV encoding

— on-card biometric comparison parameters based on extensible TLV encoding for constructing valid probe data in the on-card biometric comparison format

— examples of data record contents,

— application specific requirements, recommendations, and best practices in data determining minutiae location, direction, and type, and

— conformance test assertions and conformance test procedures applicable to this part of ISO/IEC 39794.

NOTE Although ISO/IEC 39794-4 covers finger, palm, toe as well as foot image data, this part of ISO/IEC 39794 only covers finger minutiae and is neither applicable to palms, toes or feet.

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.

http://www.w3.org/XML/Schema

ISO/IEC 39794-1, Information technology — Biometric data interchange formats — Part 1: Framework

ISO/IEC 39794-4, Information technology – Biometric data interchange formats – Part 4: Finger Image Data

ISO/IEC 29794-1, Information technology — Biometric sample quality — Part 1: Framework

ISO/IEC 8824-1, Information technology – Abstract Syntax Notation One (ASN.1) – Part 1: Specification of basic notation

ISO/IEC 8825-1, Information technology – ASN.1 encoding rules – Part 1: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER), and Distinguished Encoding Rules (DER)

ISO/IEC 19785-3, Information technology — Common Biometric Exchange Formats Framework — Part 3: Patron format specifications

ISO/IEC 7816-11, Identification cards — Integrated circuit cards — Part 11: Personal verification through biometric methods

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382-37, ISO/IEC 39794-1 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
capture device spatial sampling rate

number of pixels per unit distance used by a sensor or scanning device to initially capture an image

3.2
image spatial sampling rate

number of pixels per unit distance in the image

Note 1 to entry This may be the result of processing a captured image. The original captured scanned image may have been subsampled, scaled, down-sampled, or otherwise processed.

3.3
palm

friction ridge skin on the side and underside of the hand

3.4
fingerprint image

representation of an area of friction skin on the fleshy surface of a finger located horizontally between the two edges of the fingernail and vertically between the first joint and the tip of a finger

Note 1 to entry It contains a unique pattern of friction ridge and valley information commonly referred to as a “fingerprint”.

3.5
friction ridge

ridge present on the skin of the fingers and toes, the palms and soles of the feet, which makes contact with an incident surface under normal touch

Note 1 to entry On the fingers, the unique patterns formed by the friction ridges make up fingerprints.

3.6
minutia

point where a single friction ridge deviates from an uninterrupted flow

Note 1 to entry Deviation may take the form of ending, bifurcation, or a more complicated “composite” type.

3.7
typeline

one of the two innermost friction ridges that start parallel, diverge, and surround or tend to surround the pattern area

3.8
delta

point on a ridge at or nearest to the point of divergence of two typelines and located at or directly in front of the point of divergence"

3.9
core

topmost point on the innermost recurving ridgeline of a fingerprint

Note1 to entry Generally, the core is placed upon or within the innermost recurve of a loop.

3.10
4-neighbour of a pixel p

pixel that is the top, bottom, left, or right neighbour of p

EXAMPLE The pixels *e*, *f*, *g*, and *h* in the following table are 4-neighbours of pixel *p*.

a	e	b
h	p	f
d	g	c

3.11
4-path from pixel p0 to pixel pn

sequence of pixels (p_0, p_1, p_2, ..., p_n) such that p_i is a 4-neighbour of p_{i-1}

3.12
4-connected set of pixels

set S of pixels such that for any two pixels p, $q \in S$ there exists a 4-path from p to q

3.13
8-neighbour of a pixel p

pixel that is a 4-neighbour or a diagonal (top-left, top-right, bottom-left, or bottom-right) neighbour of *p*

EXAMPLE The pixels a, b, c, d, e, f, g, and h in the table are 8-neighbours of pixel p.

a	e	b
h	p	f
d	g	c

3.14
8-path from pixel p0 to pixel pn

sequence of pixels (p0, p1, p2, …, pn) such that pi is an 8-neighbour of pi-1

3.15
8-connected set of pixels

set S of pixels such that for any two pixels p, q ∈ S there exists an 8-path from p to q

3.16
border ∂S of a set of pixels S

subset $\partial S = \{x \in S : x \text{ is 4-neighbour of } q, q \notin S\}$ of pixels of S that are 4-neighbours of pixels outside S

3.17
loop

type of fingerprint classification pattern where the friction ridges arrange themselves in the form of a lasso, making a backward turn without a twist

3.18
whorl

type of fingerprint classification pattern where the friction ridges form a revolution around the centre

4 Symbols and abbreviated terms

For the purposes of this document, the abbreviations given in ISO/IEC 39794-1 and the following apply.

ICC	Integrated Circuit Card
ppcm	pixels per centimetre
ppi	pixels per inch
TIR	Total Internal Reflection

5 Conformance

A biometric data record conforms to this part of ISO/IEC 39794 if it satisfies all of the normative requirements related to:

- its data structure, data values and the relationships between its data elements as specified throughout Clauses 7 and 8 and Annex A of this part of ISO/IEC 39794, and
- the relationship between its data values and the input biometric data from which the biometric data record was generated as specified throughout Clauses 7 and 8 and Annex A of this part of ISO/IEC 39794.

NOTE: A biometric Data Block will always comply with only one of the following formats:

- Tagged binary encoding as specified in Clause 8.1, or
- XML encoding as specified in Clause 8.2, or
- Binary encoding for on-card biometric comparison as specified in Clause 8.3

A system that produces biometric data records is conformant to this part of ISO/IEC 39794 if all biometric data records that it outputs conform to this part of ISO/IEC 39794 (as defined above) as claimed in the Implementation Conformance Statement (ICS) associated with that system. A system does not need to be capable of producing biometric data records that cover all possible aspects of this part of ISO/IEC 39794, but only those that are claimed to be supported by the system in the Implementation Conformance Statement.

A system that uses biometric data records is conformant to this part of ISO/IEC 39794 if it can read, and use for the purpose intended by that system, all biometric data records that conform to this part of ISO/IEC 39794 (as defined above) as claimed in the ICS associated with that system. A system does not need to be capable of using biometric data records that cover all possible aspects of this part of ISO/IEC 39794, but only those that are claimed to be supported by the system in an ICS.

6 Modality Specific Information

6.1 Purpose

This clause defines the placement of minutiae on the fingerprint. Compatible minutiae extraction is required for interoperability between different finger comparators for the purposes of comparing an individual against previously collected and stored finger biometric data. Interoperability is based on the definition of the finger minutiae extraction rules, the definition of the ASN.1 format (Clause 8.1 and Annex A.1), the definition of the XML encoding format (Clause 8.2 and Annex A.2), and the on-card biometric comparison format (Clause 8.3) that are common to many finger comparators for acceptable comparing accuracy, while allowing for extended data to be attached for use with equipment that is compatible with it.

6.2 Minutia description

Establishment of a common feature-based representation shall rest on agreement on the fundamental notion for representing a fingerprint. Minutiae are points located at the places in the fingerprint image where friction ridges end or split into two ridges. Describing a fingerprint in terms of the location and direction of these ridge endings and bifurcations provides sufficient information to reliably determine whether two fingerprint records are from the same finger.

The specifications of minutia location and minutia direction described below accomplish this. See Figures 2 through 4 for an illustration of the definitions below.

6.3 Minutia kind

6.3.1 General

There are two major kinds of minutiae: a “ridge skeleton end point” and a “ridge skeleton bifurcation point” or split point. There are other kinds of “points of interest” in the friction ridges that occur much less frequently and are more difficult to define precisely. More complex kinds of minutiae are usually a combination of the basic kinds defined above. Some points are neither a ridge ending nor a bifurcation. Therefore, this document defines an additional kind named “other”, which shall be used for such a case. The “other” minutiae kind shall not be used for minutiae that are ridge endings or ridge bifurcations.

Therefore, the following kinds of minutiae are distinguished:

- ridge ending
- ridge bifurcation
- other.

A ridge ending may — alternatively — be referred to as a valley bifurcation depending on the method to determine its position (Clause 6.4.3 and 6.4.5).

6.3.2 Unique minutia

A minutia shall be encoded once. A minutia is uniquely identified by the location and angle.

6.3.3 Encoding trifurcations

The location at which a ridge splits into three separate ridges is a trifurcation. If it is encoded, it shall be encoded as two bifurcations with identical (x,y) values and different orientation angle values.

6.4 Minutia location

6.4.1 General

The minutia location is represented by its horizontal and vertical position. The minutiae determination strategy considered in this document relies on skeletons derived from a digital fingerprint image. The ridge skeleton is computed by thinning down the ridge area to single pixel wide lines. The valley skeleton is computed by thinning down the valley area to single pixel wide lines. If other methods are applied, they should approximate the skeleton method, i.e. location and angle of the minutia should be equivalent to the skeleton method.

6.4.2 Coordinate system

The coordinate system used to express the minutiae of a fingerprint shall be a Cartesian coordinate system. Points shall be represented by their X and Y coordinates. The origin of the coordinate system shall be the upper left corner of the original image with X increasing to the right and Y increasing downward. Note that this is in agreement with most imaging and image processing use. When viewed on the finger, X increases from right to left as shown in Figure 1. All X and Y values are non-negative.

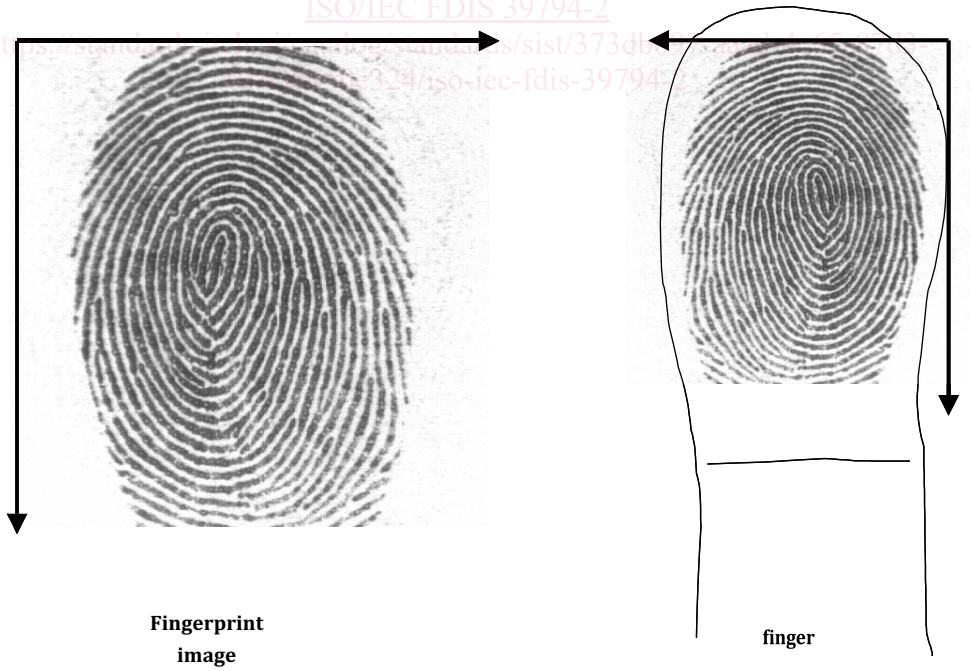

Figure 1 — Coordinate System