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Information technology — Extensible biometric data interchange formats —

Part 4:
Finger image data

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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 document 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 Joint 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.

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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 ISO/IEC 19794 series. From 2011 onwards, the second generation of biometric data interchange formats was published in the second edition of the established parts and the first edition of some new parts of the ISO/IEC 19794 series. 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 were harmonized across all parts of the ISO/IEC 19794 series, and 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 the ISO/IEC 39794 series as a 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 image data interchange formats complements ISO/IEC 19794-4 (both the 2005 and 2011 editions). The first generation of biometric data interchange formats, which has been adopted, e.g. by ICAO for the biometric data stored in machine readable travel documents, is expected to be retained in the standards catalogue as long as needed.

This document is intended for those applications requiring the exchange of raw or processed fingerprint and other friction ridge images (for example, palm images) that may not necessarily be limited in the amount of resources available for data storage or transmitting time. It can be used for the exchange of scanned fingerprints containing detailed image pixel information.

Use of the captured or processed image allows interoperability among biometric systems relying on minutiae-based, pattern-based or other algorithms. Thus, data from the captured finger image offers the developer more freedom in choosing or combining comparison algorithms. For example, an enrolment image may be stored on a contactless chip located on an identification document. This will allow future verification of the holder of the document with systems that rely on either minutiae-based or pattern-based algorithms. Establishment of an image-based representation of fingerprint information will not rely on pre-established definitions of minutiae, patterns or other types. It will provide implementers with the flexibility to accommodate images captured from dissimilar devices, varying image sizes, spatial sampling rates and different greyscale depths. Use of the finger image will allow each vendor to implement their own algorithms to determine whether two fingerprint records are from the same finger.

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

Information technology — Extensible biometric data interchange formats —

Part 4:
Finger image data

1 Scope

This document specifies:

— generic extensible data interchange formats for the representation of friction ridge image data: a tagged binary data format based on an extensible specification in ASN.1 and a textual data format based on an XML schema definition that are both capable of holding the same information;

— examples of data record contents;

— application specific requirements, recommendations, and best practices in data acquisition; and

— conformance test assertions and conformance test procedures applicable to this document.

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

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

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 14495-1, *Information technology — Lossless and near-lossless compression of continuous-tone still images: Baseline*

ISO/IEC 15444 (all parts), *Information technology — JPEG 2000 image coding system*

ISO/IEC 15948, *Information technology — Computer graphics and image processing — Portable Network Graphics (PNG): Functional specification*

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

W3C Recommendation, *XML Schema Part 1: Structures* (Second Edition), 28 October 2004

W3C Recommendation, *XML Schema Part 2: Datatypes* (Second Edition), 28 October 2004

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 terminological databases for use in standardisation at the following addresses:

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

— ISO Online Browsing Platform available at http://www.iso.org/obp.

3.1
spatial sampling rate
number of pixels per unit distance used by a sensor or scanning device to initially capture an image

3.2
coding model
procedure used to convert input data into symbols to be coded

3.3
coding process
general term for referring to an encoding process, a decoding process, or both

3.4
column
samples per line in an image

3.5
compressed data
either compressed image data or table specification data or both

3.6
compressed image data
coded representation of an image

Note 1 to entry: As specified in Annex F.

3.7
compression
reduction in the number of bits used to represent source image data

3.8
decoder
embodiment of a decoding process

3.9
decoding process
process which takes as its input compressed image data and outputs a continuous-tone image

3.10
dequantization
inverse procedure to quantization by which the decoder recovers a representation of the DWT coefficients

3.11
reconstructed image
<data>continuous-tone image which is the output of the decoder

Note 1 to entry: As defined in Annex F.

3.12
source image
<data>continuous-tone image used as input to any encoder

Note 1 to entry: As defined in Annex F.

3.13
digital image
<data>two-dimensional array of data

3.14
downsampling
procedure by which the spatial resolution of an image is reduced

3.15
DWT
discrete wavelet transform
linear transformation, implemented by a multirate filter bank, that maps a digital input signal to a collection of output subbands

3.16
encoder
embodiment of an encoding process

3.17
encoding process
process which takes as its input a continuous-tone image and outputs compressed image data

3.18
entropy-coded data segment
independently decodable sequence of entropy encoded bytes of compressed image data

3.19
entropy decoder
embodiment of an entropy decoding procedure

3.20
entropy decoding
lossless procedure which recovers the sequence of symbols from the sequence of bits produced by the entropy coder

3.21
entropy encoder
embodiment of an entropy encoding procedure

3.22
entropy encoding
lossless procedure which converts a sequence of input symbols into a sequence of bits such that the average number of bits per symbol approaches the entropy of the input symbols

3.23
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”.

3.24
Huffman decoder
embodiment of a Huffman decoding procedure

3.25
Huffman decoding
entropy decoding procedure which recovers the symbol from each variable length code produced by the Huffman encoder

3.26
Huffman encoder
embodiment of a Huffman encoding procedure

3.27
Huffman encoding
entropy encoding procedure which assigns a variable length code to each input symbol

3.28
Huffman table
set of variable length codes required in a Huffman encoder and Huffman decoder

3.29
image data
either source image data or reconstructed image data

3.30
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, downsampled, or otherwise processed.

3.31
interchange format
representation of compressed image data for exchange between application environments

3.32
lossless
descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedure(s) is identical to the input to the encoding procedure(s)

3.33
marker
two-byte code in which the first byte is FF_{Hex} and the second byte is a value between 1 and FE_{Hex}

3.34
marker segment
marker and associated set of parameters

3.35
palm
friction ridge skin on the side and underside of the hand

3.36
parameter
fixed length integers 8, 16, or 32 bits in length, used in the compressed data format

3.37
plain fingerprint image
image captured from a finger placed on a platen without any rolling movement

3.38
procedure
set of steps which accomplishes one of the tasks which comprise an encoding or decoding process

3.39
progressive
<coding>separation of data segments into blocks that can be transmitted successively to allow the compressed image data to be decoded at successively higher levels of resolution

3.40
quantization table
set of quantization values (i.e., bin widths) used to quantize DWT coefficients within the subbands

3.41
quantize
act of performing the quantization procedure for a DWT coefficient

3.42
restart interval
number of coefficients processed as an independent sequence within an image

3.43
restart marker
marker that separates two restart intervals in an image

3.44
rolled fingerprint image
image captured that is located between the two edges of the fingernail

Note 1 to entry: This type of image is typically acquired using a rolling motion from one edge of the fingernail to the other.

3.45
run length
number of consecutive symbols of the same value

3.46
SWT
symmetric wavelet transform
linear transform implemented by applying a DWT to a periodized symmetric extension of the input signal

3.47
sample
one element in the two-dimensional array which comprises a finger image

3.48
table specification data
coded representation from which the tables, used in the encoder and decoder, are generated

3.49
upsampling
procedure by which the spatial resolution of an image is increased

4 Abbreviated terms

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

ppcm	pixels per centimetre
ppi	pixels per inch
CTF	contrast transfer function
JPEG	joint photographic experts group
MTF	modulation transfer function
PGM	portable gray map

PNG	portable network graphics
TIR	total internal reflection
WSQ	wavelet scalar quantization

5 Conformance

A biometric data block (BDB) conforms to this document if it satisfies all of the requirements related to:

— its data structure, data values and the relationships between its data elements as specified throughout Clauses 6, 7, 8, and Annex A, and

— the relationship between its data values and the input biometric data from which the biometric data record was generated as specified throughout Clauses 6, 7, 8, and Annex A.

A system that produces biometric data records conforms to this document if all biometric data records that it outputs conform to this document (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 document, but only those that are claimed to be supported by the system in the ICS.

A system that uses biometric data records conforms to this document if it can read, and use for the purpose intended by that system, all biometric data records that conform to this document (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 document, but only those that are claimed to be supported by the system in an ICS.

6 Modality specific information

6.1 Capture recommendations

6.1.1 Fingerprint image

This document is designed to accommodate both plain (flat) or rolled fingerprint images. Biometric systems perform better if the volar pad of the finger is centred both horizontally and vertically in the image capture area. Therefore, when capturing a fingerprint image, the centre of the fingerprint image should be located in the approximate centre of the image capture area.

For multiple finger verification and/or identification purposes, there exist fingerprint capture devices that will acquire images of multiple fingers during a single capture cycle. These devices are capable of capturing the plain impressions from two, three or four adjacent fingers of either hand during a single scanning. The plain impressions from the two thumbs or two index fingers can also be captured at one time. Therefore, with three placements of the fingers on a device's scanning surface all ten fingers from an individual would be acquired in three scans – right four fingers, left four fingers, and two thumbs. For these multi-finger captures, half of the captured fingers should be located to the left of the image centre and the other half of the fingers to the right of the image centre.

6.1.2 Palm image

This document is also designed to accommodate images from the palm of the hand or from the side of the hand opposite the thumb also known as the "writer's palm". Most comparison subsystems perform better if the flat or fleshy part of the palm or writer's palm is centred both horizontally and vertically in the image capture area. Therefore, when capturing a palmprint image, the centre of the palm or writer's palm image area should be located in the approximate centre of the image capture area. The palm itself may be captured as one entity, or various pieces of it can be captured as single images such as the thenar (fleshy part behind the thumb), hypothenar (fleshy area opposite the thumb), or interdigital (area of the palm directly beneath the four fingers).

6.2 Image coordinate system considerations

The recorded image data shall appear to be the result of a scanning of an impression of a friction ridge image. For the purpose of describing the position of each pixel within an image to be exchanged, a pair of reference axes shall be used. The origin of the axes, pixel location (0,0), shall be located at the upper left-hand corner of each image. The x-coordinate (horizontal) position shall increase positively from the origin to the right side of the image. The y-coordinate (vertical) position shall increase positively from the origin to the bottom of the image.

To assure that friction ridge images are interoperable with existing fingerprint images in legacy datasets, care shall be taken to assure that the orientation of the fingerprint is correct. Figure 1 shows how this shall be achieved.

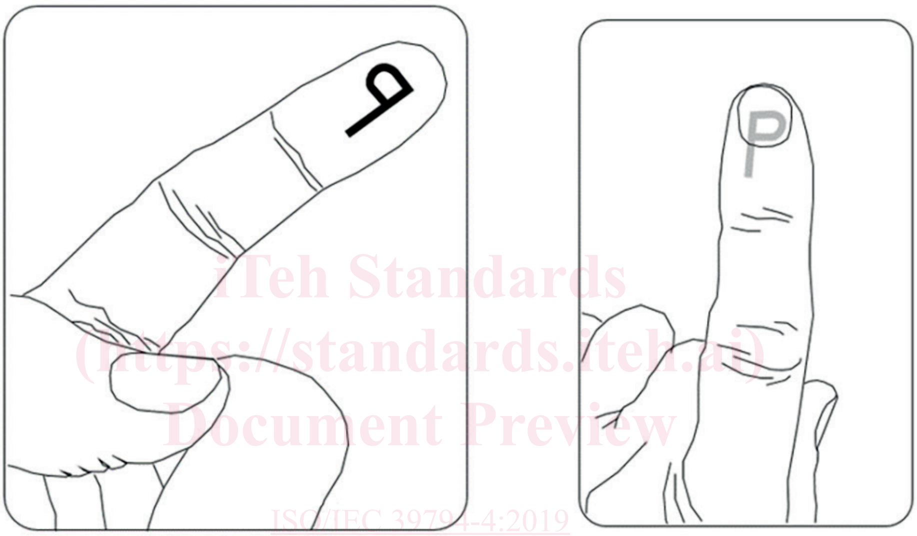

Figure 1 — Illustration of fingerprint orientation

6.3 Image representation requirements

6.3.1 General

Image representation requirements are dependent on various factors including the application, the available amount of raw pixel information to retain or exchange, and targeted performance metrics. Because of these factors, the images represented will have characteristics based on the aspects described in 6.3.2 through 6.3.5.

6.3.2 Colorspace

Finger images shall be represented as greyscale image data.

6.3.3 Pixel aspect ratio

The finger image shall be represented using square pixels, in which the horizontal and vertical dimensions of the pixels are equal. Any difference between these two dimensions should be within 1 %, i.e. the ratio of horizontal to vertical pixel dimensions should be between 0,99 and 1,01.

6.3.4 Bit-depth

The greyscale precision of the pixel data shall be specified in terms of the bit-depth or the number of bits used to represent the greyscale value of a pixel. A bit-depth of 8 provides 256 levels of grey. For greyscale data, the minimum value that can be assigned to a "black" pixel shall be zero. The maximum value that can be assigned to a "white" pixel shall be the greyscale value with all of its bits of precision set to "1". However, the “blackest" pixel in an image may have a value greater than "0" and the "whitest" pixel may have a value less than its maximum value.

6.3.5 Image spatial sampling rate

The spatial sampling rate of the image data formatted and recorded for interchange establishes the number of pixels for a given distance over the fingerprint object. A finger image may be represented with a certain number of pixels per cm (ppcm) or pixels per inch (ppi). A finger image with a sampling rate of 197 ppcm is practically equivalent to a finger image with a sampling rate of 500 ppi. For example, if a spatial sampling rate of 500 ppi is established for a fingerprint sensor with a width of 0.635 cm (corresponding to a quarter inch), there will be 125 pixels across the width of the image.

7 Abstract data elements

7.1 Purpose and overall structure

This clause describes the contents of data elements defined in this document. The description is independent of the encoding of the data elements.

The full naming conventions for ASN.1 module components and component types definitions, naming conventions for XML schema elements and element types definitions also ASN.1 and XML schema definition extensions applied per the ISO/IEC 39794 series are specified in ISO/IEC 39794-1.

The tagged binary encoding as well as the XML encoding is given in Clause 8 and Annex A.

The structure of the abstract data elements is described in Figure 2.

