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**Information technology — Extensible
biometric data interchange formats —
Part 6:
Iris image data**

*Technologies de l'information — Formats d'échange de données
biométriques extensibles —*

Partie 6: Données d'image de l'iris



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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see patents.iec.ch).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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.

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.

Introduction

The purpose of this document is to define an International Standard for the exchange of iris image extensible information. This document contains a specific definition of iris image record attribute data elements, record's tagged binary and XML encoding extensible formats for storing and transmitting the iris image and certain attribute data elements, and conformance criteria.

Currently, the exchange of iris information between equipment from different vendors can be achieved using images of the eye. While some applications can successfully operate with full size uncompressed rectilinear images, there are others for which this is expensive in terms of storage and bandwidth. This document therefore also defines compact representations.

Biometric data interchange formats enable the interoperability of different biometric systems. The first generation of biometric data interchange formats was 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 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 those related to biometric sample quality have been added, the header data structures have been harmonized across all parts of the ISO/IEC 19794 series, and an XML encoding has been added in addition to the binary encoding.

In anticipation of the future need for additional data elements and in order 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).

~~Annex A~~ specifies the ASN.1 schema and XML schema of the formal structure description to which tagged binary encoded and XML encoded iris image extensible records are to conform (respectively).

~~Annex B~~ provides sample iris image extensible record encodings. ~~Annex C~~ includes normative assertions for testing conformance of iris image extensible records. Finally, ~~Annex D~~ gives recommendations on iris image capture.

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Information technology — Extensible biometric data interchange formats —

Part 6: Iris image data

1 Scope

This document specifies:

- generic extensible data interchange formats for the representation of iris 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. The iris image information is stored as:

- an array of intensity values optionally compressed with ISO/IEC 15948 or ISO/IEC 15444-1, or — an array of intensity values optionally compressed with ISO/IEC 15948 or ISO/IEC 15444-1 that can be cropped around the iris, with the iris at the centre, and which can incorporate region-of-interest masking of non-iris regions.

This document also specifies elements of conformance testing methodology, test assertions, and test procedures, as applicable to this document.

It establishes:

- test assertions pertaining to the structure of the iris image data format, as specified in [Clauses 6, 7, 8 and 9](#) of this document,
- test assertions pertaining to internal consistency by checking the types of values that may be contained within each field, and
- semantic test assertions.

The conformance testing methodology specified in this document does not establish:

- tests of other characteristics of biometric products or other types of testing of biometric products (e.g. acceptance, performance, robustness, security), or
- tests of conformance of systems that do not produce data records conforming to the requirements of this document.

This document does not establish:

- requirements on the optical specifications of cameras, or
- requirements on photometric properties of iris images, or
- requirements on enrolment processes, workflow and use of iris equipment.

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: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER) — Part 1*

ISO/IEC 15444-1, *Information technology — JPEG 2000 image coding system — Part 1: Core 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,
<http://www.w3.org/TR/xmlschema-1/>

W3C Recommendation, *XML Schema Part 2: Datatypes Second Edition*, 28 October 2004,
<http://www.w3.org/TR/xmlschema-2/>

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 2382-37 and ISO/IEC 39794-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 defocus

image impairment due to the position of the *iris* (3.4) along the optical axis of the camera away from the plane or surface of best focus, generally resulting in reduced sharpness (blur) and reduced contrast

3.2 depth of field

distance range relative to the entrance aperture of a capture device over which the *iris* (3.4) image has greater than a specified quality with respect to focus

3.3 greyscale

continuous-tone image that has one component, which is pixel intensity

3.4 iris

coloured annular structure in the front portion of the eye comprised of muscular and connective tissue and pigmented layers, that defines the *pupil* (3.9) and controls its size

3.5 iris centre

centre of a circle modelling the boundary between *iris* (3.4) and *sclera* (3.12)

3.6**iris radius**

radius of a circle modelling the boundary between *iris* (3.4) and *sclera* (3.12)

3.7**margin**

distance in an image from the iris-sclera border, when modelled as a circle, to the closest image border, expressed in pixels

Note 1 to entry: Throughout this document, margins are defined in terms of the *iris radius*, R (3.6). When written as an ordered pair, the order is (horizontal, vertical).

EXAMPLE (0,6 R , 0,2 R) indicates that for an iris radius of R , there shall be margins of image data 0,6 $\cdot R$ to the right and left of the *iris* (3.4) and 0,2 $\cdot R$ above and below the iris.

3.8**Modulation Transfer Function****MTF**

ratio of the image modulation to the object modulation as a function of *spatial frequency* (3.14)

3.9**pupil**

optical opening in the centre of the eye that serves as a variable light aperture and defines the inner boundary of the *iris* (3.4)

3.10**pupil centre**

average of coordinates of all the pixels lying on the boundary of the *pupil* (3.9) and the *iris* (3.4)

3.11**round**

mathematical function applied to a number x such that $\text{round}(x)$ is the integer that is closest in value to x

3.12**sclera**

generally white wall of the eye peripheral to the *iris* (3.4)

3.13**segmentation**

process of determining, within an image containing an *iris* (3.4), the boundaries between areas containing visible iris tissue and those that do not

Note 1 to entry: This process is preceded by localization of the iris, and typically followed by cropping or masking regions that are not iris tissue.

3.14**spatial frequency**

measure of the spatial period of a sinusoidal intensity pattern in space, in units of cycles/degree or of cycles/mm at a given target range

3.15**spatial sampling rate**

number of picture elements (pixels) per unit distance in the object plane or per unit angle in the imaging system

4 Symbols and abbreviated terms

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

JPEG2000	Joint Photographic Experts Group enhanced compression standard for images, as defined in ISO/IEC 15444
PGM	Netpbm greyscale image format
PPM	Netpbm colour image format
PNG	Portable Network Graphics lossless compression standard for images, as defined in ISO/IEC 15948
VGA	Video Graphics Array image format, having width 640 pixels and height 480 pixels

5 Conformance

A BDB conforms to this document if it satisfies all of the requirements related to:

- a) its data structure, data values and the relationships between its data elements as specified throughout [Clauses 6, 7, 8](#) and [Annex A](#) of this document, and
- b) 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](#) of this document.

A system that produces biometric data records is conformant to this document if all biometric data records that it outputs conform to this document (as defined in points a) to b) above) as claimed in the 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. The test for output record conformance shall be conducted in accordance with the normative content of [Annex C](#).

A system that uses biometric data records is conformant 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 in points a) to b) 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.

A binary BDB conforms to this document if it satisfies the format requirements with respect to its structure, with respect to relations among its fields, and with respect to relations between its fields and the underlying input that are specified within A.1.

An XML document conforms to this document if it satisfies the format requirements with respect to its structure, with respect to relations among its fields, and with respect to relations between its fields and the underlying input that are specified within A.2.

6 Iris image content specification

6.1 General

This clause establishes requirements on the semantic content of the images that are allowed by this document. These requirements relate to the geometric structure, pre-processing, compression protocol, format and dimensions of the image data. (Guidance on iris image capture is given in [Annex D](#).) Image data may be uncompressed or compressed. If uncompressed, then it shall be encoded using PGM or PPM image format^[3]. All uncompressed raw images shall have an 8 bit pixel depth. Images with a pixel depth other than 8 bits shall be encoded using PNG or JPEG2000.

The remaining subclauses of [Clause 6](#) group these requirements according to the type of image. As shown in [Table 1](#), four image types are defined according to a hierarchy inherited from an

unconstrained abstract basic iris image. The associated abstract values are provided in [subclause 7.3.3](#). The requirements of [Clause 7](#) establish the encoding specifications for the image.

NOTE The specifications of image types, compression protocols, formats and cropping dimensions in this first edition of this document have been determined by the NIST Interoperable Iris Exchange (IREX-1) study^[6] (2009), which was commissioned for this purpose.

Table 1 — Hierarchy of iris image types

FORMAT NAME	Iris Centring	Margins (R : iris radius)		Width and height pixels	Data size kB	Compression mode	Data encoding method
		Horizontal	Vertical				
IMAGE_TYPE_UNCROPPED	no	$\geq 0,6R$	$\geq 0,2R$	unspecified	variable	none	PGM or PPM
					variable	lossless	PNG or JPEG2000
					variable	lossy	JPEG2000
IMAGE_TYPE_VGA	no	$\geq 0,6R$	$\geq 0,2R$	$W = 640$ $H = 480$	307,2	none	PGM or PPM
					typically 70-140	lossless	PNG or JPEG2000
					variable	lossy	JPEG2000
IMAGE_TYPE_CROPPED	yes	$=0,6R$	$=0,2R$	unspecified	variable	none	n/a
					typically 40-70	lossless	PNG or JPEG2000
					typically 8-24 (compact)	lossy (see NOTE 4)	JPEG2000
IMAGE_TYPE_CROPPED_AND_MASKED	yes	$=0,6R$	$=0,2R$	unspecified	variable	none	n/a
					typically 20-50	lossless	PNG or JPEG2000
					typically 2-6 (compact)	lossy	JPEG2000

NOTE 1 The application of lossy compression to IMAGE_TYPE_UNCROPPED images is not recommended for images with spatial sampling rate below 10 pixels/mm.

NOTE 2 Typical data sizes for IMAGE_TYPE_CROPPED and IMAGE_TYPE_CROPPED_AND_MASKED assume an iris of approximately 120 pixels radius. Other sizes are listed as variable to reflect variations in spatial sampling rate and in iris size.

NOTE 3 The use of cropping, masking, or lossy compression can degrade iris recognition accuracy.

NOTE 4 For applications of 1:1 comparison, the compressed IMAGE_TYPE_CROPPED data size can be as low as 3,5 kB.

6.2 Uncropped iris image

An uncropped iris image shall contain a raster scan image of a single eye. An example is shown in [Figure 1](#). For an iris radius of R , there shall be margins of image data at least $0,2R$ above and below the iris, and at least $0,6R$ to the right and left of the iris. These margins of image data shall be acquired from

the actual object being imaged, not synthesized values. It is not assumed that the iris is centred within the image.

If uncropped image data is compressed, then ideally it should be compressed losslessly. PNG shall not be used in its interlaced mode. If JPEG2000 is used, image data shall be stored in JPEG2000 format.

The uncropped iris image type shall be identified in the iris record by assigning the abstract value *uncropped* to the iris image type element in [subclause 7.3.3](#), as defined in [Table 3](#).

6.3 VGA iris image

A VGA iris image is a special case of the uncropped iris image; the image width shall be 640 pixels and the image height shall be 480 pixels. An example is shown in [Figure 1](#). Additional constraints of margins and container are inherited from the uncropped image type in [subclause 6.2](#).

If images are compressed, then images shall be compressed in accordance with either PNG or JPEG2000 for lossless compression, or JPEG2000 for lossy compression.

The VGA iris image type shall be identified in the iris record by assigning the abstract value *vGA* to the iris image type element in [7.3.3](#), as defined in [Table 3](#).

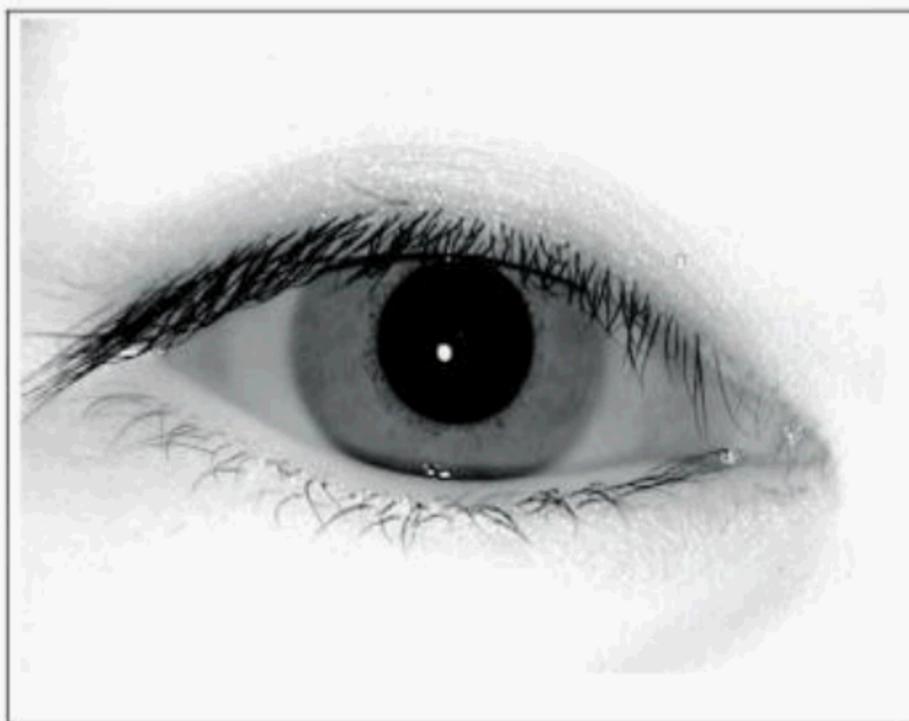


Figure 1 — Example of uncropped iris image or VGA iris image

6.4 Cropped iris image

A cropped version of a rectilinear iris image may be instantiated. This supports moderately compact storage. It requires a coarse localization of the iris.

The cropped rectilinear image shall contain an iris centred relative to the geometric centre of the raster representation. An example is shown in [Figure 2](#).

The crop region shall be sized such that a margin $0,6R$ pixels wide is included on both the right and left sides of the iris, where R is an estimate of the iris radius. Margins above and below the iris shall include $0,2R$ pixels. Margin pixels shall represent actual sensor readings, not substitute values.

Parts of the iris estimated to have been cropped during capture (i.e. absent in the input image) shall be replaced with pixels of value 0. Note that records with partially or fully missing iris data should not ordinarily be generated; instead, the defect should be detected and another capture attempted.

The cropped iris image type inherits all of the normative requirements of the uncropped iris image type in 6.2 with respect to compression.

The cropped iris image type shall be identified in the iris record by assigning the abstract value *cropped* to the iris image type element in 7.3.3, as defined in Table 3.



Figure 2 — Example of cropped iris image

6.5 Cropped and masked iris image

6.5.1 General

A cropped rectilinear image may be masked to produce a highly compressible image. This masking operation involves pixels in three regions: the upper and lower eyelids, and the sclera. A mask shall consist of a single grey value assigned to a four-connected region of pixels. Examples are shown in Figure 3. The utility of this approach has been documented in the academic literature^[4].

In the cropped and masked iris image type, the image regions outside of the iris itself shall be masked with specified below uniform pixel values in order to increase compressibility and to ensure that coding bytes are allocated maximally to the iris texture itself.

When upper and/or lower eyelids are detected within the cropped image, then pixels in these eyelid regions and beyond shall be replaced with the value 128, such that normal methods for detecting and fitting such eyelid boundaries in unmasked images may continue to function with the cropped and masked iris image type. Note that none, one or both of the upper or lower eyelids may occlude the iris (see Figure 3). In all these cases, the pixels in the sclera shall be replaced uniformly as specified in 6.5.2 with the value 200, and if any eyelid regions are detected, pixels in those regions and beyond shall be replaced with the value 128 as specified in 6.5.3.

The cropped and masked iris image type inherits all of the normative requirements of the cropped iris image type in subclause 6.4 with respect to compression.

The cropped and masked iris image type shall be identified in the iris record by assigning the abstract value *croppedAndMasked* to the iris image type element in 7.3.3, as defined in Table 3.

NOTE Masking serves compressibility only; the presence of a mask grey value is not a reliable segmentation indicator. When an image is compressed, the mask value can be altered by the compression algorithm.

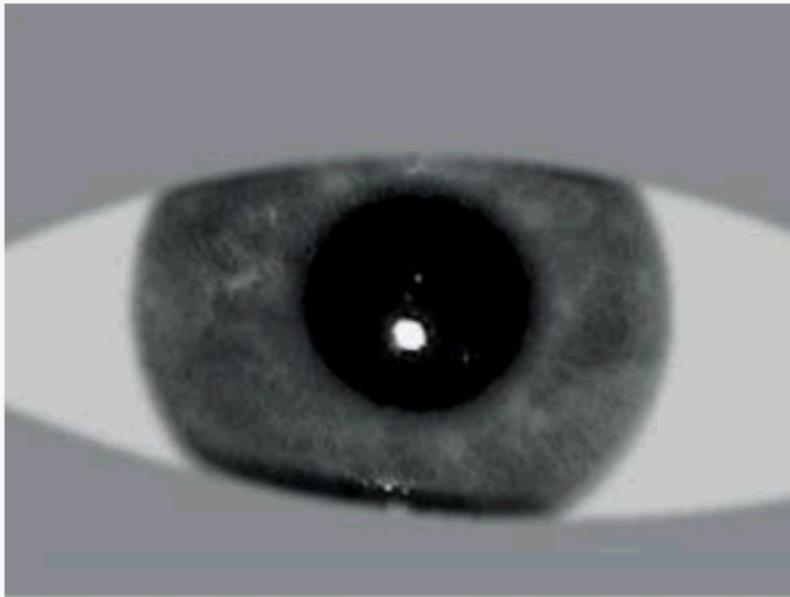
6.5.2 Masking of the sclera

The pixels in the sclera region shall be substituted with a fixed mask value of 200. The sclera mask shall extend to the first and last columns unless the extremes of the upper and lower eyelids meet inside the left or right image boundary.

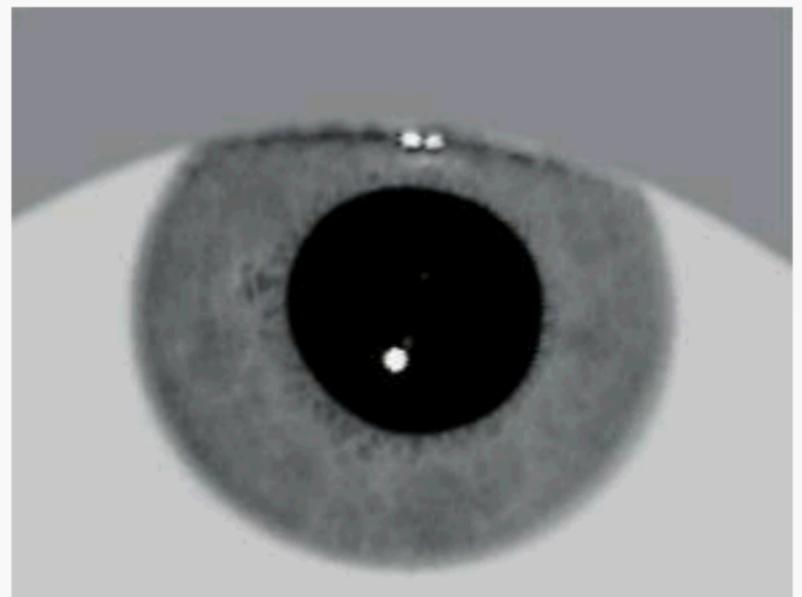
6.5.3 Masking of the eyelids

The pixels in the upper and lower eyelid regions shall be substituted with a fixed mask value of 128.

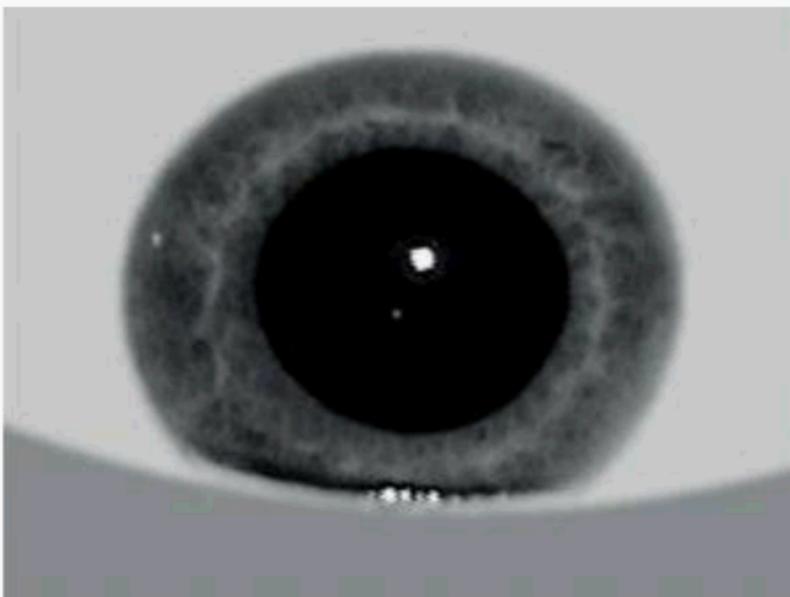
The upper eyelid mask shall extend to the first (top) row of the image. The upper eyelid mask shall extend to the leftmost and rightmost columns of the image. The lower eyelid mask shall extend to the last (bottom) row of the image. The lower eyelid mask shall extend to the leftmost and rightmost columns of the image.



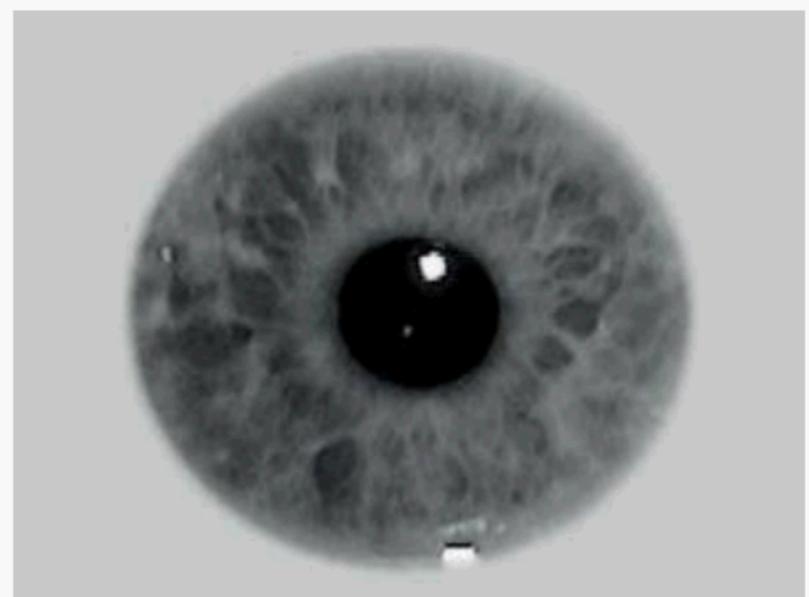
(a) Iris occluded by both eyelids



(b) Iris occluded by the upper eyelid and not the lower eyelid



(c) Iris occluded by the lower eyelid and not the upper eyelid



(d) Iris is not occluded by eyelids

Figure 3 — Examples of cropped and masked iris images

6.5.4 Mask transition blurring

The transitions from iris and sclera regions to the eyelid mask regions, and from the iris to the sclera mask regions, shall be locally smoothed to minimize the boundary's impact on the compression coding budget.

The method shall be as follows: After the eyelid mask and the sclera mask values have replaced the original image pixel values, the borders of these mask regions shall be smoothed by low-pass filtering. Each image pixel, whose centred 7×7 neighbourhood contains at least one mask pixel, shall be replaced

by a weighted sum of a 7×7 binomial kernel. The coefficients of this kernel, K , are defined by the outer product:

$$K = 1/(64 \times 64) UU^T$$

where

$$U = [1, 6, 15, 20, 15, 6, 1]^T$$

The border-smoothing pixel values shall be computed after the masking operation but before further pixel replacement begins. In the case of pixels that belong to both the iris-sclera mask transition and the iris or sclera to eyelid transition neighbourhoods, the replacement values used shall be those of the eyelid border-smoothing operation.

7 Abstract data elements

7.1 Purpose and overall structure

This clause describes the contents of data elements defined in this document. These descriptions are independent of the encoding of the data elements.

The presence of data elements is specified in [Annex A](#).

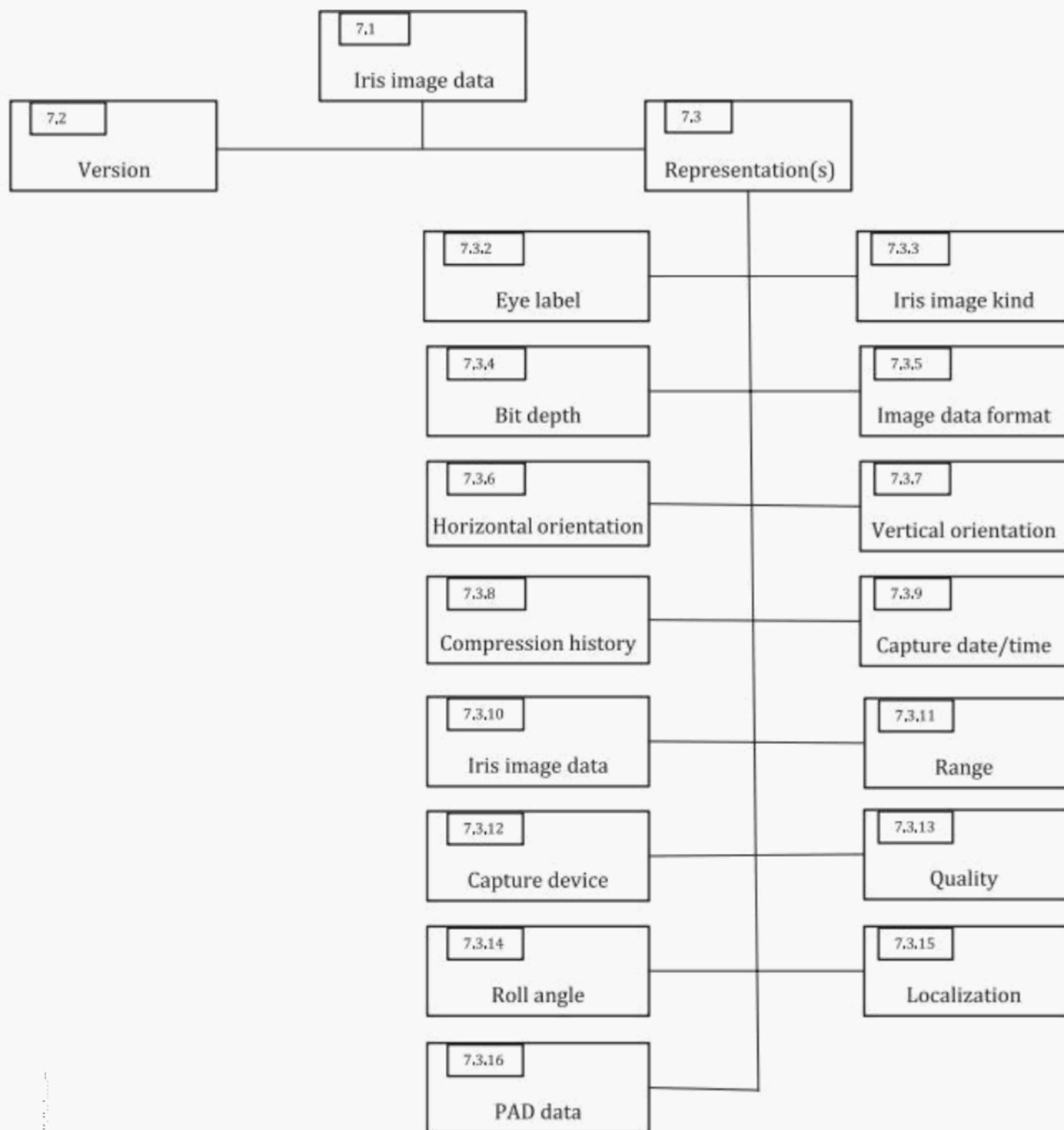
For an explanation of the XML schema definition see [A.2](#). A tagged binary encoding in ASN.1 is described in [A.1](#).

Each BDB shall pertain to a single subject and shall contain one or more images of a human iris. The organization of the record format is as follows:

- A version number containing information about the version used for encoding. See [7.2](#).
- A representation element for each iris representation. See [7.3](#).

The structure of the abstract data elements is additionally informatively described in [Figure 4](#). Naming conventions for ASN.1 modules, types and components in the ISO/IEC 39794 series and definition extensions in ASN.1 are specified within the common framework standard ISO/IEC 39794-1:2019, Clause 9.

Naming conventions for XML schema definitions, types and elements in the ISO/IEC 39794 series and definition extensions in XML are specified within the common framework standard ISO/IEC 39794-1:2019, Clause 10.



Key

7.n.n

in the upper left of a box, denotes that this element is defined in subclause 7.n.n.

Figure 4 — Iris image data block

The figure is not automatically generated and should only be viewed as a high level overview of the structure.

7.2 Version block

Abstract values: The abstract values for the version block are defined in ISO/IEC 39794-1.

Contents: The generation number of this document shall be 3. The year shall be the year of the publication of this document. See ISO/IEC 39794-1.

7.3 Representation block

7.3.1 General

This data element is the container for all the data associated with the iris image, except for the version block information.

7.3.2 Eye label

Abstract values: unknown, rightIris, leftIris

Contents: This element refers to the subject's own eyes label. See [Table 2](#) for a description of the abstract values.

Table 2 — Abstract values for Eye Label

Abstract value	Description
unknown	It is unknown if the image is the subject's right or left eye.
rightIris	It is an image of the subject's right eye.
leftIris	It is an image of the subject's left eye.

7.3.3 Iris image kind

Abstract values: uncropped, vGA, cropped, croppedAndMasked

Contents: This element refers to the kind of iris image. The image shall conform to the normative requirements of the subclauses cited in [Table 3](#).

Table 3 — Image kinds and their requirements

Image kind	Abstract value	Description	Governing subclauses
1	uncropped	An uncropped rectilinear iris image.	6.2
2	vGA	A rectilinear iris image in VGA (640 × 480) format.	6.3
3	cropped	A cropped, centred, iris image with (0,6R 0,2R) margins.	6.4
7	croppedAndMasked	A cropped and region-of-interest masked, centred, iris image with (0,6R 0,2R) margins.	6.5 with subclauses 6.5.1 , 6.5.2 , 6.5.3 , 6.5.4

7.3.4 Bit depth

Abstract values: An integer 8 to 24.

Contents: This element refers to the bit depth in bits per pixel. Images having more than 8 bits per pixel shall be encoded using PNG or JPEG2000.

7.3.5 Image data format

Abstract values: pgm, ppm, png, jpeg2000Lossless, jpeg2000Lossy

Contents: This element refers to image data format. See [Table 4](#) for a description of the abstract values.

In the event that a greyscale iris image is encoded in the Netpbm portable greyscale binary image format (PGM), the format definition is as follows:

- 1) A "magic number" = "P5" for identifying the file type followed by
- 2) Any Whitespace (blanks, TABs, CRs, LFs).
- 3) A width, formatted as ASCII characters in decimal.
- 4) Any Whitespace (blanks, TABs, CRs, LFs).
- 5) A height, again in ASCII decimal.
- 6) Any Whitespace (blanks, TABs, CRs, LFs).
- 7) The maximum grey value (Maxval), again in ASCII decimal. Shall be less than 65536, and more than zero.
- 8) A single Whitespace character (usually a newline).
- 9) A raster of Height rows, in order from top to bottom. Each row consists of Width grey values, in order from left to right. Each grey value is a number from 0 through Maxval, with 0 being black and Maxval being white. Each grey value is represented in pure binary by either 1 or 2 bytes. If the Maxval is less than 256, it is 1 byte. Otherwise, it is 2 bytes. The most significant byte is first.

A PGM encoded greyscale iris image shall be encoded in a P5 format.

In the event that a colour iris image is encoded in the Netpbm portable colour binary image format (PPM), the format definition is as follows:

- 1) A "magic number" = "P6" for identifying the file type followed by
- 2) Any Whitespace (blanks, TABs, CRs, LFs).
- 3) A width, formatted as ASCII characters in decimal.
- 4) Any Whitespace (blanks, TABs, CRs, LFs).
- 5) A height, again in ASCII decimal.
- 6) Any Whitespace (blanks, TABs, CRs, LFs).
- 7) The maximum channel value (Maxval), again in ASCII decimal. Shall be less than 256, and more than zero.
- 8) A single Whitespace character (usually a newline).
- 9) A raster of Height rows, in order from top to bottom. Each row consists of Width pixel values, in order from left to right. Each pixel value is represented by 1 number for red, 1 number for green and 1 number for blue, each from 0 through Maxval; thus each pixel value is represented in pure binary by 3 bytes.

A PPM encoded colour iris image shall be encoded in a P6 format.

Table 4 — Abstract values for image data format

Abstract value	Description
pgm	Image shall be monochrome and uncompressed using PGM format as defined in 7.3.5.
ppm	Image shall be colour and uncompressed using PPM format as defined in 7.3.5.
png	Image shall be monochrome or colour and compressed using PNG algorithm as specified in ISO/IEC 15948.
jpeg2000Lossless	Image shall be monochrome or colour and compressed losslessly using JPEG2000 algorithm as specified in ISO/IEC 15444-1, in JPEG2000 lossless file format.
jpeg2000Lossy	Image shall be monochrome or colour and compressed using JPEG2000 algorithm as specified in ISO/IEC 15444-1, in JPEG2000 lossy file format.

7.3.6 Horizontal orientation

Abstract values: undefined, leftToRight, rightToLeft

Contents: This element refers to the horizontal orientation of the image. See [Table 5](#) for a description of the abstract values.

Table 5 — Abstract values for horizontal orientation

Abstract value	Description
Unknown	The horizontal orientation is unknown.
leftToRight	Left side of subject's eye (i.e. nasal side of subject's left eye, or temporal side of subject's right eye) is on left side of the image as viewed.
rightToLeft	Horizontal orientation is opposite from that described for leftToRight, i.e. mirrored about a vertical axis.

7.3.7 Vertical orientation

Abstract values: undefined, topToBottom, bottomToTop

Contents: This element refers to the vertical orientation of the image. See [Table 6](#) for a description of the abstract values.

Table 6 — Abstract values for vertical orientation

Abstract value	Description
unknown	The vertical orientation is unknown.
topToBottom	Superior edge of subject's eye is at top of image.
bottomToTop	Vertical orientation is opposite from that described for topToBottom, i.e. mirrored about a horizontal axis.

7.3.8 Compression history

Abstract values: undefined, losslessOrNone, lossy

Contents: This element refers to the image compression history and indicates whether lossy or lossless compression occurred. See [Table 7](#) for a description of the abstract values.

Table 7 — Abstract values for compression history

Abstract value	Description
unknown	Compression history is unknown.
losslessOrNone	The image was not compressed, or was losslessly compressed, before being represented in the current format.
lossy	The image was lossy compressed before being represented in the current format.

7.3.9 Capture date/time block

Abstract values: The abstract values for the capture date/time block are defined in ISO/IEC 39794-1.

Contents: The *capture date/time block* element shall indicate when the capture of this representation started in Coordinated Universal Time (UTC), as specified in ISO/IEC 39794-1.

7.3.10 Iris image data

Abstract values: Octet string.

Contents: This data element contains the encoded iris image data.

7.3.11 Range

Abstract values: unassigned, failed, overflow, range (2 to 65533)

Contents: This element specifies an estimate of the distance between the optical centre of the camera lens and the subject iris, measured in mm, or whether an attempt to estimate the range has been made, but failed. See [Table 8](#) for a description of the abstract values.

NOTE The magnification cannot be derived from the range value if the camera can change its focal length, using a zoom lens or other method.

Table 8 — Abstract values for range

Abstract value	Description
unassigned	No range estimation attempt.
failed	Range estimation attempt has been made, but failed.
overflow	Range overflow (exceeds 2^{-12}).
range	Distance between the optical centre of the camera lens and the subject iris, measured in mm (2^1 to 2^{1-2}).

7.3.12 Capture device block

7.3.12.1 Model identifier block

See ISO/IEC 39794-1.

7.3.12.2 Capture device technology identifier

Abstract values: unknown, CMOS/CCD

Contents: This data element shall indicate the class of capture device technology used to acquire the captured biometric sample. See [Table 9](#) for a description of the abstract values.

Table 9 — Abstract values for capture device technology identifier

Abstract value	Description
unknown	The technology is unknown or unspecified.
CMOS/CCD	The technology is CMOS/CCD.

7.3.12.3 Certification identifier blocks

Abstract values: The abstract values for the certification identifier block are defined in ISO/IEC 39794-1.

Contents: This element contains at least one *certification identifier block* element. See ISO/IEC 39794-1.

7.3.13 Quality blocks

Abstract values: The abstract values for the quality block are defined in ISO/IEC 39794-1. This

Contents: element contains at least one *quality block* element. See ISO/IEC 39794-1.

7.3.14 Roll angle block

7.3.14.1 General

Iris image capture systems that record images of both eyes simultaneously can have the capability to measure the roll angle of the subject's head, for example, by defining a line between the pupil centres of the left and right eyes and determining the angular difference between this line and the horizontal axis of the imaging system. This information can be useful for the matching process and to expedite searching large databases.

7.3.14.2 Relative roll angle

Abstract values: One integer 0 to 65534

Contents: This element specifies the relative roll angle between head and camera. It shall be measured in degrees between the horizontal axis of the camera system and the line between the centres of the two eyes, with a positive value signifying counter-clockwise rotation, as seen from the camera, of the line between the eyes. The value is obtained as follows:

$$\text{Roll angle} = (\text{unsigned short}) \text{ round } (65534 \times \text{angle}/360) \text{ modulo } 65535$$

7.3.14.3 Roll angle uncertainty

Abstract values: One integer 0 to 65534

Contents: This element specifies the roll angle uncertainty. It is an estimate, dependent on the imaging device, of the maximum error associated with the roll angle and shall be measured as a nonzero value in degrees. The value is obtained as follows:

Roll angle uncertainty = (unsigned short) round (65534 x uncertainty/180) with $0 \leq \text{uncertainty} < 180$

where uncertainty is measured in degrees and is the absolute value of maximum error.

7.3.15 Localization block

7.3.15.1 General

These optional values of expected centre and diameter limits are intended to guide the iris localization and segmentation process. They might be populated either per image, by an iris localization step during capture, or per camera, based on capture-specific constants such as image size, magnification and depth of field. This guidance can speed up localization and can avoid segmentation errors due to overly large search ranges. Note that depending on the accuracy of the recorded values, the guided search can miss the correct iris segmentation. These values can be used or ignored during subsequent processing. The set of six element is optional, but they shall be either all present or all absent.

7.3.15.2 Iris centre X smallest

Abstract values: One integer 0 to 65535

Contents: This element specifies the smallest expected iris centre X coordinate in pixels, measured from the left side of the image. 0 denotes an undefined value.

7.3.15.3 Iris centre X largest

Abstract values: One integer 0 to 65535

Contents: This element specifies the largest expected iris centre X coordinate in pixels, measured from the left side of the image. 0 denotes an undefined value.

7.3.15.4 Iris centre Y smallest

Abstract values: One integer 0 to 65535

Contents: This element specifies the smallest expected iris centre Y coordinate in pixels, measured from the top of the image. 0 denotes an undefined value.

7.3.15.5 Iris centre Y largest

Abstract values: One integer 0 to 65535

Contents: This element specifies the largest expected iris centre Y coordinate in pixels, measured from the top of the image. 0 denotes an undefined value.

7.3.15.6 Iris diameter smallest

Abstract values: One integer 0 to 65535

Contents: This element specifies the smallest expected iris diameter in pixels. 0 denotes an undefined value.

7.3.15.7 Iris diameter largest

Abstract values: One integer 0 to 65535

Contents: This element specifies the largest expected iris diameter in pixels. 0 denotes an undefined value.

7.3.16 PAD data block

Abstract values: The abstract values for the PAD data block are defined in ISO/IEC 39794-1.

Contents: This element contains a PAD data block, as specified in ISO/IEC 39794-1.

8 Encoding

8.1 Tagged binary encoding

The data format defined in this document allows the extension of definitions in a backward and forward compatible manner (see ISO/IEC 39794-1 for definition extension in ASN.1). ~~Subclause A.1~~ specifies an ASN.1 schema, in which the abstract data elements of ~~Clause 7~~ shall follow ASN.1 types defined within one of the following document: the ASN.1 standard ISO/IEC 8824-1, ISO/IEC 39794-1, or by this document.

The tagged binary encoding of an iris image data block shall be obtained by applying the ASN.1 Distinguished Encoding Rules (DER) defined within ISO/IEC 8825-1 to a value of the type `IrisImageDataBlock` defined in the given ASN.1 module. The DER encoding of each data object has three parts: tag octets that identify the data object, length octets that give the number of subsequent value octets, and the value octets.

The ASN.1 module in ~~A.1~~ can be retrieved from <https://standards.iso.org/iso-iec/39794/-6/ed-1/en>.

8.2 XML encoding

The data format defined in this document allows the extension of definitions in a backward and forward compatible manner (see ISO/IEC 39794-1 for definition extension in XML). ~~A.2~~ specifies an XSD schema, in which the abstract data elements of ~~Clause 7~~ shall follow XML types defined within one of the following standards: the W3C Recommendations, *XML Schema Parts 1 and 2*, ISO/IEC 39794-1, or this document.

An XML document encoding iris image data shall obey the given XSD.

The XSD in ~~A.2~~ can be retrieved from <https://standards.iso.org/iso-iec/39794/-6/ed-1/en>.

9 Registered BDB format identifiers

The registrations listed in ~~Table 10~~ have been made with the Biometric Registration authority (see^[1]) to identify the iris image record interchangeable formats defined in this document. The format owner is ISO/IEC JTC 1/SC 37, with the registered biometric organization identifier 257 (0101Hex).

Table 10 — BDB format identifier

BDB format identifier	Short name	Full object identifier
44 (002CHex)	g3-binary-iris-image	{iso(1) registration-authority(1) cbeff(19785) biometric-organization(0) jtc1-sc37(257) bdbs(0) g3-binary-iris-image(44) }
45 (002DHex)	g3-xml-iris-image	{iso(1) registration-authority(1) cbeff(19785) biometric-organization(0) jtc1-sc37(257) bdbs(0) g3-xml-iris-image(45) }

Annex A (normative)

Formal specifications

A.1 ASN.1 module for tagged binary encoding

The ASN.1 module below can be retrieved from <https://standards.iso.org/iso-iec/39794/-6/ed-1/en>.

```
ISO-IEC-39794-6-ed-1-v1 {iso(1) standard(0) iso-iec-39794(39794) part-6(6) ed-1(1) v1(1)
iso-iec-39794-6(0)}
-- Use of ISO/IEC copyright in this Schema is licensed for the purpose of
-- developing, implementing, and using software based on this Schema, subject
-- to the following conditions:
--
-- * Software developed from this Schema shall retain the Copyright Notice,
-- this list of conditions and the disclaimer below ("Disclaimer").
--
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-- contributors, may be used to endorse or promote software derived from
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-- identify the ISO/IEC standard from which it is taken. Such attribution
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-- Please reproduce this note if possible."), may be placed in the
-- software itself or any other reasonable location.
--
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-- THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT,
-- INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT
-- NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE,
-- DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY
-- THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT
-- (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF
-- THE CODE COMPONENTS, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
DEFINITIONS IMPLICIT TAGS ::= BEGIN
IMPORTS
RegistryIdBlock,
VersionBlock,
QualityBlocks,
CertificationIdBlocks,
PADDataBlock,
CaptureDateTimeBlock
FROM ISO-IEC-39794-1-ed-1-v1;
IrisImageKindCode ::= ENUMERATED {
    uncropped          (1),
    vGA                 (2),
    cropped             (3),
    croppedAndMasked   (7)
}
IrisImageKindExtensionBlock ::= SEQUENCE {
    fallback [0] IrisImageKindCode,
    ...
}
IrisImageKind ::= CHOICE {
    code [0] IrisImageKindCode,
    extensionBlock[1] IrisImageKindExtensionBlock
}
```

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```
}
HorizontalOrientationCode ::= ENUMERATED {
    undefined      (0),
    leftToRight    (1),
    rightToLeft    (2)
}
VerticalOrientationCode ::= ENUMERATED {
    undefined      (0),
    topToBottom    (1),
    bottomToTop    (2)
}
CompressionHistoryCode ::= ENUMERATED {
    undefined      (0),
    losslessOrNone (1),
    lossy          (2)
}
CaptureDeviceTechnologyIdCode ::= ENUMERATED {
    unknown  (0),
    cMOSCCD (1)
}
CaptureDeviceTechnologyIdExtensionBlock ::= SEQUENCE {
    fallback [0] CaptureDeviceTechnologyIdCode,
    ...
}
CaptureDeviceTechnologyId ::= CHOICE {
    code [0] CaptureDeviceTechnologyIdCode,
    extensionBlock[1] CaptureDeviceTechnologyIdExtensionBlock
}
EyeLabelCode ::= ENUMERATED {
    unknown  (0),
    rightIris (1),
    leftIris (2)
}
CaptureDeviceBlock ::= SEQUENCE {
    modelIdBlock [0] RegistryIdBlock OPTIONAL,
    technologyId[1] CaptureDeviceTechnologyId OPTIONAL,
    certificationIdBlocks[2] CertificationIdBlocks OPTIONAL,
    ...
}
ImageDataFormatCode ::= ENUMERATED {
    pgm          (0),
    ppm          (1),
    png          (2),
    jpeg2000Lossless (3),
    jpeg2000Lossy  (4)
}
ImageDataFormatExtensionBlock ::= SEQUENCE {
    ...
}
ImageDataFormat ::= CHOICE {
    code [0] ImageDataFormatCode,
    extensionBlock[1] ImageDataFormatExtensionBlock
}
RangingErrorCode ::= ENUMERATED {
    unassigned (0),
    failed      (1),
    overflow    (2)
}
RangeOrError ::= CHOICE {
    range [0] INTEGER (2..65533),
    errorCode[1] RangingErrorCode
}
RollAngleBlock ::= SEQUENCE {
    angle [0] INTEGER (0..65534),
    uncertainty[1] INTEGER (0..65534) OPTIONAL
}
Coordinate ::= INTEGER (1..65535)
Diameter ::= INTEGER (1..65535)
LocalisationBlock ::= SEQUENCE {
    irisCenterXSmallest[0] Coordinate OPTIONAL,
    irisCenterXLargest[1] Coordinate OPTIONAL,

```

```

    irisCenterYSmallest[2] Coordinate      OPTIONAL,
    irisCenterYLargest[3] Coordinate      OPTIONAL,
    irisDiameterSmallest[4] Diameter      OPTIONAL,
    irisDiameterLargest[5] Diameter      OPTIONAL
}
RepresentationBlock ::= SEQUENCE {
    eyeLabelCode [0] EyeLabelCode,
    irisImageKind [1] IrisImageKind,
    bitDepth [2] INTEGER (8..24),
    imageDataFormat [3] ImageDataFormat,
    horizontalOrientationCode [4] HorizontalOrientationCode,
    verticalOrientationCode [5] VerticalOrientationCode,
    compressionHistoryCode [6] CompressionHistoryCode,
    captureDateTimeBlock [7] CaptureDateTimeBlock,
    irisImageData [8] OCTET STRING,
    range [9] RangeOrError                OPTIONAL,
    captureDeviceBlock [10] CaptureDeviceBlock  OPTIONAL,
    qualityBlocks [11] QualityBlocks          OPTIONAL,
    rollAngleBlock [12] RollAngleBlock        OPTIONAL,
    localisationBlock [13] LocalisationBlock    OPTIONAL,
    pADDataBlock [14] PADDataBlock           OPTIONAL,
    ...
}
RepresentationBlocks ::= SEQUENCE OF RepresentationBlock
IrisImageDataBlock ::= [APPLICATION 6] SEQUENCE {
    versionBlock [0] VersionBlock,
    representationBlocks[1] RepresentationBlocks,
    ...
}
END

```

A.2 XML schema definition for XML encoding

The XSD module below can be retrieved from <https://standards.iso.org/iso-iec/39794/-6/ed-1/en>.

```

<?xml version = "1.0" encoding = "utf-8" ?>
-- Use of ISO/IEC copyright in this Schema is licensed for the purpose of
-- developing, implementing, and using software based on this Schema, subject
-- to the following conditions:
--
-- * Software developed from this Schema shall retain the Copyright Notice,
-- this list of conditions and the disclaimer below ("Disclaimer").
--
-- * Neither the name or logo of ISO or of IEC, nor the names of specific
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-- * The software developer shall attribute the Schema to ISO/IEC and
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-- (e.g., "This software makes use of the Schema from ISO/IEC 39794-6
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-- Please reproduce this note if possible."), may be placed in the
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-- THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT,
-- INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT
-- NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE,
-- DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY
-- THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT
-- (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF
-- THE CODE COMPONENTS, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
<xs:schema
  xmlns:xs = "http://www.w3.org/2001/XMLSchema"
  xmlns:vc= "http://www.w3.org/2007/XMLSchema-versioning"
  xmlns:cmn = "https://standards.iso.org/iso-iec/39794/-1"

```

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```
xmlns = "https://standards.iso.org/iso-iec/39794/-6"
targetNamespace = "https://standards.iso.org/iso-iec/39794/-6"
elementFormDefault = "qualified"
attributeFormDefault = "unqualified"
vc:minVersion="1.0">

<xs:import schemaLocation="iso-iec-39794-1-ed-1-v1.xsd" namespace="https://standards.
iso.org/iso-iec/39794/-1"/>

<xs:complexType name = "IrisImageKindCodeType">
  <xs:choice>
    <xs:element name = "uncropped" type="xs:int" fixed="1" />
    <xs:element name = "vGA" type="xs:int" fixed="2" />
    <xs:element name = "cropped" type="xs:int" fixed="3" />
    <xs:element name = "croppedAndMasked" type="xs:int" fixed="7" />
  </xs:choice>
</xs:complexType>

<xs:complexType name = "IrisImageKindExtensionBlockType">
  <xs:sequence>
    <xs:element name="fallback" type="IrisImageKindCodeType"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name = "IrisImageKindType">
  <xs:choice>
    <xs:element name = "code" type="IrisImageKindCodeType"/>
    <xs:element name = "extensionBlock" type="IrisImageKindExtensionBlockType"/>
  </xs:choice>
</xs:complexType>

<xs:complexType name = "HorizontalOrientationCodeType">
  <xs:choice>
    <xs:element name = "undefined" type="xs:int" fixed="0"/>
    <xs:element name = "leftToRight" type="xs:int" fixed="1"/>
    <xs:element name = "rightToLeft" type="xs:int" fixed="2"/>
  </xs:choice>
</xs:complexType>

<xs:complexType name = "VerticalOrientationCodeType">
  <xs:choice>
    <xs:element name = "undefined" type="xs:int" fixed="0"/>
    <xs:element name = "topToBottom" type="xs:int" fixed="1"/>
    <xs:element name = "bottomToTop" type="xs:int" fixed="2"/>
  </xs:choice>
</xs:complexType>

<xs:complexType name = "CompressionHistoryCodeType">
  <xs:choice>
    <xs:element name = "undefined" type="xs:int" fixed="0"/>
    <xs:element name = "losslessOrNone" type="xs:int" fixed="1"/>
    <xs:element name = "lossy" type="xs:int" fixed="2"/>
  </xs:choice>
</xs:complexType>

<xs:complexType name = "CaptureDeviceTechnologyIdCodeType">
  <xs:choice>
    <xs:element name = "unknown" type="xs:int" fixed="0" />
    <xs:element name = "cMOSCCD" type="xs:int" fixed="1" />
  </xs:choice>
</xs:complexType>

<xs:complexType name = "CaptureDeviceTechnologyIdExtensionBlockType">
  <xs:sequence>
    <xs:element name="fallback" type="CaptureDeviceTechnologyIdCodeType"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name = "CaptureDeviceTechnologyIdType">
```

```

    <xs:choice>
      <xs:element name = "code" type="CaptureDeviceTechnologyIdCodeType"/>
      <xs:element name = "extensionBlock" type="CaptureDeviceTechnologyIdExtensionBlockT
type"/>
    </xs:choice>
  </xs:complexType>

  <xs:complexType name = "EyeLabelCodeType">
    <xs:choice>
      <xs:element name = "unknown" type="xs:int" fixed="0"/>
      <xs:element name = "rightIris" type="xs:int" fixed="1"/>
      <xs:element name = "leftIris" type="xs:int" fixed="2"/>
    </xs:choice>
  </xs:complexType>

  <xs:complexType name = "CaptureDeviceBlockType">
    <xs:sequence>
      <xs:element name = "modelIdBlock" type = "cmn:RegistryIdBlockType" minOccurs = "0"/>
      <xs:element name = "technologyId" type = "CaptureDeviceTechnologyIdType" minOccurs =
"0"/>
      <xs:element name = "certificationIdBlocks" type="cmn:CertificationIdBlocksType"
minOccurs = "0"/>
      <xs:any minOccurs="0" namespace="##other" processContents="lax" />
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name = "ImageDataFormatCodeType">
    <xs:choice>
      <xs:element name = "pgm" type="xs:int" fixed="0" />
      <xs:element name = "ppm" type="xs:int" fixed="1" />
      <xs:element name = "png" type="xs:int" fixed="2" />
      <xs:element name = "jpeg2000Lossless" type="xs:int" fixed="3" />
      <xs:element name = "jpeg2000Lossy" type="xs:int" fixed="4" />
    </xs:choice>
  </xs:complexType>

  <xs:complexType name = "ImageDataFormatExtensionBlockType">
    <xs:sequence>
      <xs:any namespace="##other" processContents="lax"/>
    </xs:sequence>
  </xs:complexType>

  <xs:complexType name = "ImageDataFormatType">
    <xs:choice>
      <xs:element name = "code" type="ImageDataFormatCodeType"/>
      <xs:element name = "extensionBlock" type="ImageDataFormatExtensionBlockType"/>
    </xs:choice>
  </xs:complexType>

  <xs:complexType name = "RangingErrorCodeType">
    <xs:choice>
      <xs:element name = "unassigned" type="xs:int" fixed="0" />
      <xs:element name = "failed" type="xs:int" fixed="1" />
      <xs:element name = "overflow" type="xs:int" fixed="2" />
    </xs:choice>
  </xs:complexType>

  <xs:complexType name = "RangeOrErrorType">
    <xs:choice>
      <xs:element name = "range">
        <xs:simpleType>
          <xs:restriction base="xs:unsignedShort">
            <xs:minInclusive value="2"/>
            <xs:maxInclusive value="65533"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name = "errorCode" type="RangingErrorCodeType"/>
    </xs:choice>
  </xs:complexType>

```

```

<xs:complexType name = "RollAngleBlockType">
  <xs:sequence>
    <xs:element name = "angle">
      <xs:simpleType>
        <xs:restriction base = "xs:unsignedShort">
          <xs:maxInclusive value = "65534"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name = "uncertainty" minOccurs = "0">
      <xs:simpleType>
        <xs:restriction base = "xs:unsignedShort">
          <xs:maxInclusive value = "65534"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
  </xs:sequence>
</xs:complexType>

<xs:simpleType name="CoordinateType">
  <xs:restriction base="xs:unsignedShort">
    <xs:minInclusive value="1"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="DiameterType">
  <xs:restriction base="xs:unsignedShort">
    <xs:minInclusive value="1"/>
  </xs:restriction>
</xs:simpleType>

<xs:complexType name = "LocalisationBlockType">
  <xs:sequence>
    <xs:element name = "irisCenterXSmallest" type = "CoordinateType" minOccurs = "0"/>
    <xs:element name = "irisCenterXLargest" type = "CoordinateType" minOccurs = "0"/>
    <xs:element name = "irisCenterYSmallest" type = "CoordinateType" minOccurs = "0"/>
    <xs:element name = "irisCenterYLargest" type = "CoordinateType" minOccurs = "0"/>
    <xs:element name = "irisDiameterSmallest" type = "DiameterType" minOccurs = "0"/>
    <xs:element name = "irisDiameterLargest" type = "DiameterType" minOccurs = "0"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name = "RepresentationBlockType">
  <xs:sequence>
    <xs:element name = "eyeLabelCode" type = "EyeLabelCodeType"/>
    <xs:element name = "irisImageKind" type = "IrisImageKindType"/>
    <xs:element name = "bitDepth">
      <xs:simpleType>
        <xs:restriction base = "xs:unsignedByte">
          <xs:minInclusive value = "8"/>
          <xs:maxInclusive value = "24"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:element>
    <xs:element name = "imageDataFormat" type = "ImageDataFormatType"/>
    <xs:element name = "horizontalOrientationCode" type = "HorizontalOrientationCodeType"/>
    <xs:element name = "verticalOrientationCode" type = "VerticalOrientationCodeType"/>
    <xs:element name = "compressionHistoryCode" type = "CompressionHistoryCodeType"/>
    <xs:element name = "captureDateTimeBlock" type = "cmn:CaptureDateTimeBlockType"/>
    <xs:element name = "irisImageData" type = "xs:base64Binary"/>
    <xs:element name = "range" type = "RangeOrErrorType" minOccurs = "0"/> <xs:element
name = "captureDeviceBlock" type = "CaptureDeviceBlockType" minOccurs =
"0"/>
    <xs:element name = "qualityBlocks" type = "cmn:QualityBlocksType" minOccurs = "0"/>
    <xs:element name = "rollAngleBlock" type = "RollAngleBlockType" minOccurs = "0"/>
    <xs:element name = "localisationBlock" type = "LocalisationBlockType" minOccurs =
"0"/>
    <xs:element name = "pADDataBlock" type = "cmn:PADDataBlockType" minOccurs="0" />
  </xs:sequence>
</xs:complexType>

```

```

        <xs:any minOccurs="0" namespace="##other" processContents="lax"/>
    </xs:sequence>
</xs:complexType>

<xs:complexType name="RepresentationBlocksType">
    <xs:sequence>
        <xs:element name="representationBlock" type="RepresentationBlockType"
maxOccurs="unbounded" />
    </xs:sequence>
</xs:complexType>

<xs:complexType name = "IrisImageDataBlockType">
    <xs:sequence>
        <xs:element name = "versionBlock" type = "cmn:VersionBlockType" />
        <xs:element name = "representationBlocks" type = "RepresentationBlocksType"/>
        <xs:any minOccurs="0" namespace="##other" processContents="lax"/>
    </xs:sequence>
</xs:complexType>

<xs:element name = "irisImageData" type = "IrisImageDataBlockType"/>

</xs:schema>

```

Annex B
(informative)
Encoding examples

B.1 Sample ASN.1 encoding for iris image data

An example ASN.1 encoding can be retrieved from <https://standards.iso.org/iso-iec/39794/-6/ed-1/en>.

B.2 Sample XML encoding for iris image data

An example xml encoding can be retrieved from <https://standards.iso.org/iso-iec/39794/-6/ed-1/en>.

Annex C (normative)

Conformance testing methodology

C.1 Overview

This normative annex is intended to specify elements of the conformance testing methodology, test assertions, and test procedures as applicable to this document.

To provide sufficient information about the IUT for the testing laboratory to properly conduct a conformance test and for an appropriate declaration of conformity to be made, the supplier of the IUT shall provide the information in [Table C.1](#) and also complete the columns "IUT support" and "Supported range" in [Table C.2](#) of the current document, which applies to tested iris image extensible BDB format(s). All tables shall be provided to the testing laboratory prior to or at the same time as the IUT is provided to the testing laboratory.

Table C.1 — Identification of the supplier and the IUT

Supplier name and address	
Contact point for queries about the ICS	
Implementation name	
Implementation version	
Any other information necessary for full identification of the implementation	
Registered BDB format identifier of the format that conformance is claimed to (cf. Clause 9)	
Are any mandatory requirements of the standard not fully supported (Yes or No)	
Date of statement	

Most Level 1 and Level 2 requirements are specified in the schemas of [Annex A](#) and need not be repeated in tabular form. As specified in ISO/IEC 39794-1, this document specifies a table of optional elements that the IUT claims to support and to which a testing laboratory can attest.

Table C.2 — Requirements and options of the data format specification

Provision identifier	Reference in data format specification	Provision summary	Level	Status	Format type applicability		IUT support	Supported range	Test result
					Tagged binary encoding	XML encoding			
P1	Annex A	An iris image type may contain unknown extensions.	1 and 2	0	Y	Y			
P	Annex A	An iris image compression may contain unknown extensions.	1 and 2	0	Y	Y			
P	Annex A	A representation block may contain a capture device block.	1 and 2	0	Y	Y			
P	Annex A	A capture device block may contain a capture device identifier.	1 and 2	0	Y	Y			
P	Annex A	A capture device block may contain certification identifier blocks.	1 and 2	0	Y	Y			
P	Annex A	A capture device block may contain a capture device technology identifier.	1 and 2	0	Y	Y			
P	Annex A	A capture device technology identifier may contain unknown extensions.	1 and 2	0	Y	Y			
P8	Annex A	A capture device block may contain unknown extensions.	1 and 2	0	Y	Y			
P9	Annex A	A representation block may contain quality blocks.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A quality block may contain unknown	1 and 2	0	Y	Y			
P1	Annex A	A representation block may contain a roll angle data block.	1 and 2	0	Y	Y			
P1	Annex A	A representation block may contain a localization block.	1 and 2	0	Y	Y			
P1	Annex A	A representation block may contain a PAD data block.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A PAD data block may contain a PAD decision.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A PAD data block may contain a sequence of PAD score blocks.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A PAD data block may contain a sequence of PAD extended data blocks.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A PAD data block may contain information about the context of capture.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A PAD data block may contain information about the level of supervision/surveillance.	1 and 2	0	Y	Y			
P1	ISO/IEC 39794-	A PAD data block may contain risk level information.	1 and 2	0	Y	Y			

Table C.2

Provision identifier	Reference in data format specification	Provision summary	Level	Status	Format type applicability		IUT support	Supported range	Test result
					Tagged binary encoding	XML encoding			
P2	ISO/IEC 39794-	A PAD data block may contain information about the category of criteria for PAD.	1 and 2	0	Y	Y			
P2	ISO/IEC 39794-	A PAD data block may contain PAD parameter	1 and 2	0	Y	Y			
P2	ISO/IEC 39794-	A PAD data block may contain a sequence of PAD challenges.	1 and 2	0	Y	Y			
P2	ISO/IEC 39794-	A PAD data block may contain information about the PAD capture date and time.	1 and 2	0	Y	Y			
P2	Annex A	A representation block may contain unknown extensions.	1 and 2	0	Y	Y			

IUT support notes

To be filled in by supplier of IUT on the copy of this table provided to the testing laboratory and to be included in the copy of this table that forms part of the test report.

Test result notes

To be filled in by the testing laboratory if necessary during the execution of the conformance test and to be included in the copy of this table that forms part of the test report.

C.2 Conformance test assertions

Table C.3 details the Level 2 conformance tests that a testing organization should perform on an IUT. These Level 2 tests are necessary as the schema validation does not perform these checks. All other Level 1 and Level 2 conformance requirements are tested by schema validation.

Table C.3 — Conformance test assertions

Test identifier	Provision identifier	Conformance test assertion
T-1	7.2	VersionBlock.generation == 3
T-2	7.3.2	Iris image type matches encoding of image type

C.3 Additional information about image file formats (informative)

C.3.1 PNG file format

A PNG file starts with an 8-byte signature. The hexadecimal byte values are 89 50 4E 47 0D 0A 1A 0A. After the header comes a series of chunks, each of which conveys certain information about the image. A chunk consists of four parts: length (4 bytes), chunk type/name (4 bytes), chunk data (length bytes) and CRC (cyclic redundancy code/checksum; 4 bytes). The CRC is a network-byte-order CRC-32 computed over the chunk type and chunk data, but not the length. The IHDR chunk shall appear FIRST. It contains:

- Width: 4 bytes
- Height: 4 bytes
- Bit depth: 1 byte
- Colour type: 1 byte
- Compression method: 1 byte
- Filter method: 1 byte
- Interlace method: 1 byte

Width and height give the image dimensions in pixels. They are 4-byte integers. Zero is an invalid value. The maximum for each is $2^{31}-1$ in order to accommodate languages that have difficulty with unsigned 4-byte values.

Bit depth is a single-byte integer giving the number of bits per sample or per palette index (not per pixel). Valid values are 1, 2, 4, 8, and 16, although not all values are allowed for all colour types.

Colour type is a single-byte integer that describes the interpretation of the image data. Colour type codes represent sums of the following values: 1 (palette used), 2 (colour used), and 4 (alpha channel used). Valid values are 0, 2, 3, 4, and 6.

Bit depth restrictions for each colour type are imposed to simplify implementations and to prohibit combinations that do not compress well. Decoders shall support all valid combinations of bit depth and colour type. The allowed combinations are:

- 0: Allowed bit depths = 1, 2, 4, 8, 16. Interpretation: each pixel is a greyscale sample.
- 2: Allowed bit depths = 8, 16. Interpretation: Each pixel is an R,G,B triple.
- 3: Allowed bit depths = 1, 2, 4, 8. Interpretation: Each pixel is a palette index; a PLTE chunk shall appear.
- 4: Allowed bit depths = 8, 16. Interpretation: Each pixel is a greyscale sample; followed by an alpha sample.
- 6: Allowed bit depths = 8, 16. Interpretation: Each pixel is an R,G,B triple; followed by an alpha sample.

The sample depth is the same as the bit depth, except in the case of colour type 3, in which the sample depth is always 8 bits.

Compression method is a single-byte integer that indicates the method used to compress the image data. At present, only compression method 0 (deflate/inflate compression with a sliding window of at most 32768 bytes) is defined. All standard PNG images shall be compressed with this scheme. The compression method field is provided for possible future expansion or proprietary variants. Decoders shall check this byte and report an error if it holds an unrecognized code. See Deflate/Inflate Compression for details.

Filter method is a single-byte integer that indicates the pre-processing method applied to the image data before compression. At present, only filter method 0 (adaptive filtering with five basic filter types) is defined. As with the compression method field, decoders shall check this byte and report an error if it holds an unrecognized code.

Interlace method is a single-byte integer that indicates the transmission order of the image data. Two values are currently defined: 0 (no interlace) or 1 (Adam7 interlace).

C.3.2 JP2 file format

Logically, the structure of a JP2 file is composed of objects, being some of them optional. The first mandatory components are:

- JPEG 2000 Signature box
- File Type box
- JP2 Header box
 - Image header box
 - Bits per component box
 - Colour specification box
 - etc.
- etc.

Physically, each object in the file is encapsulated within a binary structure called a box. That binary structure is:

- LBox: Box Length. This field specifies the length of the box, stored as a 4-byte big endian unsigned integer. This value includes all of the fields of the box, including the length and type. If the value of this field is 1, then the XLBox field shall exist and the value of that field shall be the actual length of the box. If the value of this field is 0, then the length of the box was not known when the LBox field was written. In this case, this box contains all bytes up to the end of the file. If a box of length 0 is

contained within another box (its superbox), then the length of that superbox shall also be 0. This means that this box is the last box in the file. The values 2-7 are reserved for ISO use. (4 bytes coding values 0, 1 or 8 to $2^{32}-1$)

- TBox: Box Type. This field specifies the type of information found in the DBox field. The value of this field is encoded as a 4-byte big endian unsigned integer. However, boxes are generally referred to by an ISO/IEC 646 character string translation of the integer value. For all box types defined within this document, box types are indicated as both character string (normative) and as 4-byte hexadecimal integers (informative). Also, a space character is shown in the character string translation of the box type as "\040". All values of TBox not defined within this document are reserved for ISO use. (4 bytes with no fixed value). Some of the defined boxes are of the following type:
 - JPEG 2000 Signature box (jP\040\040 = 6A 50 20 20_{Hex}). The JPEG 2000 Signature box identifies that the format of this file was defined by the JPEG 2000 International Standard, as well as providing a small amount of information which can help determine the validity of the rest of the file. The JPEG 2000 Signature box shall be the first box in the file, and all files shall contain one and only one JPEG 2000 Signature box. The type of the JPEG 2000 Signature box shall be 'jP\040\040' (6A50 2020_{Hex}). The length of this box shall be 12 bytes. The contents of this box shall be the 4-byte character string '<CR><LF><87_{Hex}><LF>' (0D0A 870A_{Hex}). For file verification purposes, this box can be considered a fixed-length 12-byte string which shall have the value: 0000 000C 6A50 2020 0D0A 870A_{Hex}. The combination of the particular type and contents for this box enable an application to detect a common set of file transmission errors. The CR-LF sequence in the contents catches bad file transfers that alter newline sequences. The final linefeed checks for the inverse of the CR-LF translation problem. The third character of the box contents has its high-bit set to catch bad file transfers that clear bit 7.
 - File Type box (ftyp = 66 74 79 70_{Hex})
 - JP2 Header box (jp2h = 6A 70 32 68_{Hex}), which is a superbox containing:
 - Image Header box (ihdr = 69 68 64 72_{Hex}), which is the first block of the JP2 Header box. This box contains fixed length generic information about the image, such as the image size and number of components. The contents of the JP2 Header box shall start with an Image Header box. Instances of this box in other places in the file shall be ignored. The length of the Image Header box shall be 22 bytes, including the box length and type fields. Much of the information within the Image Header box is redundant with information stored in the codestream itself. All references to "the codestream" in the descriptions of fields in this Image Header box apply to the codestream found in the first Contiguous Codestream box in the file. Files that contain contradictory information between the Image Header box and the first codestream are not conforming files. However, readers may choose to attempt to read these files by using the values found within the codestream. The type of the Image Header box shall be 'ihdr' (6968 6472_{Hex}) and contents of the box shall have the following format: 4 bytes for the height, 4 bytes for the width, 2 bytes for the number of components, 1 byte for the bits per component, 1 byte for compression (only the value 7 is defined), 1 byte for the colourspace unknown, and 1 byte for the intellectual property.
 - Bits Per Component box (bpcc = 62 70 63 63_{Hex})
 - Colour Specification box (colr = 63 6F 6C 72_{Hex})
 - etc.
- XLBox: Box Extended Length. This field specifies the actual length of the box if the value of the LBox field is 1. This field is stored as an 8-byte big endian unsigned integer. The value includes all of the fields of the box, including the LBox, TBox and XLBox fields. (If LBox=1, 64 bytes coding 16 to $2^4 -1$; 0 bytes in any other case).
- DBox: Box Contents. This field contains the actual information contained within this box. The format of the box contents depends on the box type and will be defined individually for each type. (Variable bytes coding variable values).

Annex D (informative)

Iris image capture

D.1 Modulation Transfer Function and spatial sampling rate

The Modulation Transfer Function (MTF) of the imaging system should be attenuated to no less than 0,6 at a spatial frequency of 2 cycles/mm. The digital image that is captured from the iris should have a spatial sampling rate equal to at least 10 pixels per mm. Alternatively to measuring the MTF using sinusoids, it may also be measured using a line target (squarewave) having a frequency of 2 line pairs/mm. The corresponding maximum attenuation limit is $(4/\pi) \times 0,6$.

D.2 Compression ranges and recommended roles for the image types

Table D.1 is adapted from Figure 1 of IREX-1^[8] and illustrates the recommended image types to use in different applications (such as 1:1 verification or 1:N identification) for various target data size ranges in bytes.

Table D.1 — Image types for target record sizes and uses

Configuration		Target Record Size							
Role	Recommended type and compressor	2kB	4kB	8kB	16kB	32kB	64kB	128kB	256kB
All	IMAGE_TYPE_UNCROPPED PNG lossless or JPEG2000 lossless								
All	IMAGE_TYPE_VGA (640x480) PNG lossless or JPEG2000 lossless							■	■
All	IMAGE_TYPE_CROPPED PNG lossless or JPEG2000 lossless						■		
All	IMAGE_TYPE_CROPPED_AND_MASKED PNG lossless or JPEG2000 lossless				■	■			
1:N	IMAGE_TYPE_CROPPED JPEG2000				■	■			
1:N	IMAGE_TYPE_CROPPED_AND_MASKED JPEG2000			■	■				
1:1	IMAGE_TYPE_CROPPED JPEG2000		■	■	■				
1:1	IMAGE_TYPE_CROPPED_AND_MASKED JPEG2000	■							

D.3 Sharpness quality

Images should have adequate sharpness quality for preserving the specified spatial resolution. Figure D.1 illustrates a representative iris image with adequate resolution and sharpness quality. Note that image compression and defocus cause different types of degradations of an image. ISO/IEC 29794-6:2015, 6.2.10.3 defines a computation method for iris sharpness.

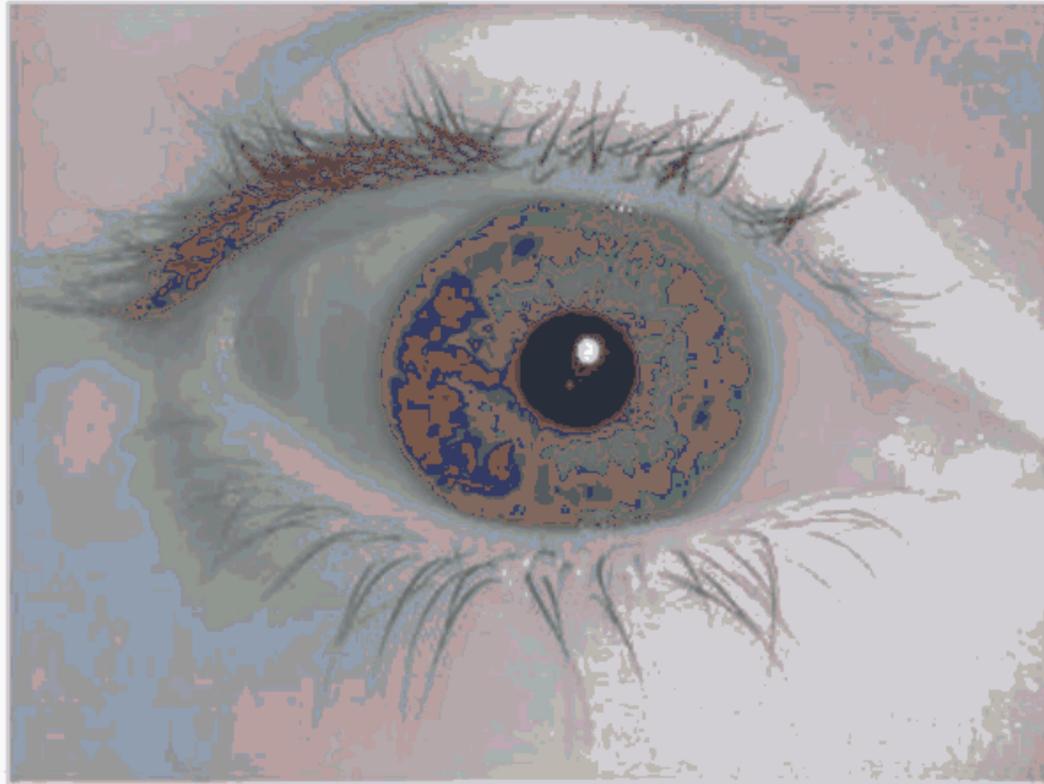


Figure D.1 — Iris image with good sharpness

D.4 Contrast

The iris image should have good grey level separation between the iris and sclera, and between the iris and pupil, as shown in [Figure D.2](#), and should have sufficient contrast to reveal the iris texture.

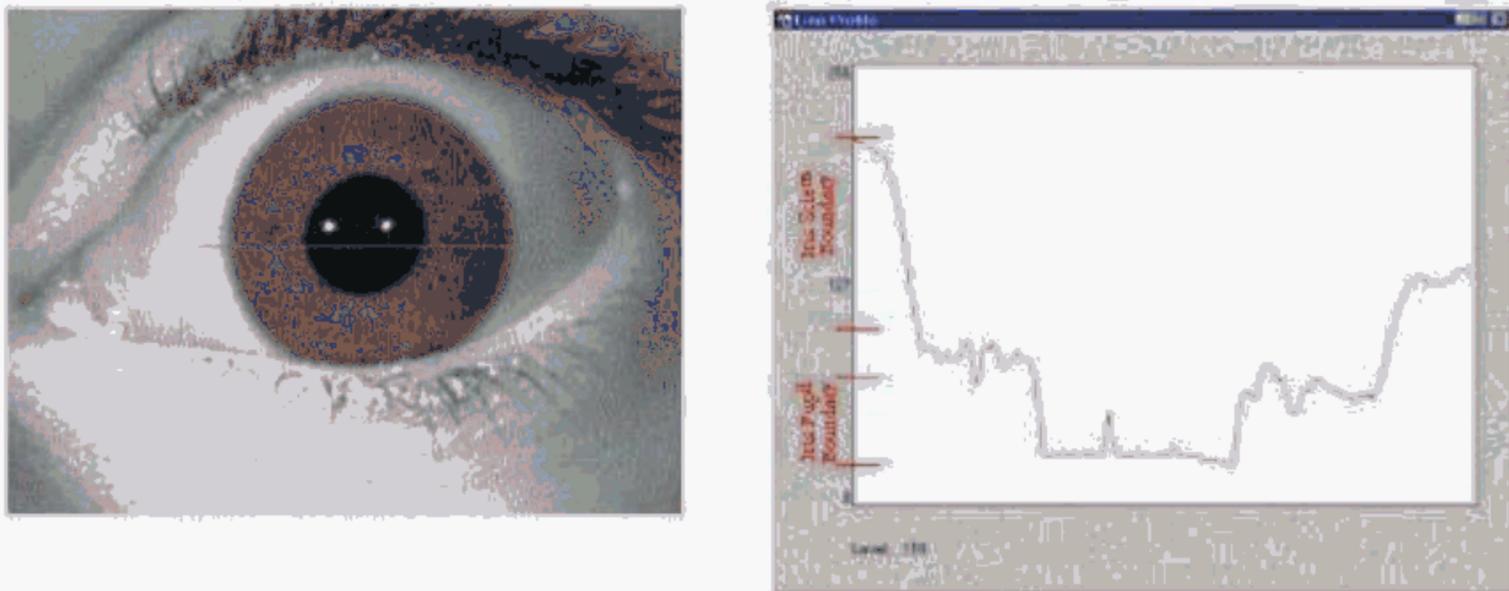


Figure D.2 — Iris image and grey level profile through the indicated line

ISO/IEC 29794-6:2015, 6.2.2.3 defines a computation method for iris-sclera contrast. Using this method:

- Iris images acquired in near-infrared should have an iris-sclera contrast above 5.
- Iris images acquired with wavelength above 900 nm may have lower iris-sclera contrast. ISO/IEC 29794-6:2015, 6.2.3.3 defines a computation method for iris-pupil contrast. Using this method:
 - Iris images acquired in near-infrared should have an iris-pupil contrast above 30.
 - Iris images acquired with visible wavelength may have lower iris-pupil contrast.

D.5 Visible iris

At least 70 % of the iris should be visible, i.e. not obscured by specular reflections, eyelids, eyelashes, or other obstructions. It is recognized that this can be difficult to achieve among some ethnic populations.

D.6 Greyscale density

The image should have a dynamic range spanning 256 grey levels, allocating one byte (8 bits) per intensity value and providing at least 7 bits of useful intensity information. If specular reflections from the illumination source occur, their intensity should be set to the saturation level (the maximum value grey level) or to a grey value of 0. Other areas within the pupil, iris and sclera of the eye should have intensities greater than 0 and less than the maximum grey level. This recommendation can be amended based on availability of performance data.

D.7 Illumination

The eye should be illuminated using near-infrared wavelengths between approximately 700 and 900 nanometres (nm). These recommendations represent current best practice, but do not preclude the use of other wavelengths, including visible light, in future systems. The angle between a line extending from the centre of the illumination source to the pupil centre, and the optical axis of the iris camera should be at least 5 degrees in order to prevent “red-eye” effect. The illumination source should be alongside or below the camera to prevent creation of shadows by the eyebrows.

D.8 Pixel aspect ratio

The image capture system should produce square pixels, in which the horizontal and vertical dimensions of the pixels are equal. Any difference between horizontal and vertical pixel dimension should be less than 1 %, that is, the ratio of horizontal to vertical pixel dimension should be between 0,99 and 1,01.

D.9 Optical distortion

The iris image should not exhibit effects of optical distortion, including spherical aberration, chromatic aberration, astigmatism and coma, consistent with standard optical design practices^[7].

D.10 Noise

Signal to noise ratio in the ocular region should be larger or equal to 36 dB.

D.11 Image orientation

The image should contain either the left or right eye and should be presented in the following canonical form:

- The image is right-side up, i.e. upper eyelids and eye brows are in the upper part of the image. —
- The tear duct (or nasal canthus) of the right eye is on the right side of the image; the tear duct of the left eye is on the left side of the image.

D.12 Presentation

In order to obtain the best iris recognition performance and interoperability, certain practices regarding presentation of the iris should be observed. Recommendations are as follows:

- The head should be held approximately vertical (not rolled either way), so that a line drawn between the centres of the left and right irises is horizontal within $\pm 10^\circ$. Some cameras will be able to measure the roll angle by imaging both eyes and constructing a line between their iris centres.
- Excessive pupil dilation might affect the quality of enrolment, so ambient illumination should be such that a pupil diameter between 20 % and 70 % of the iris diameter size is presented.
- Eyeglasses should be removed when capturing images for enrolment use in order to optimize the enrolment quality and minimize the subsequent false non-match rate.
- Hard contact lenses and patterned soft contact lenses should be removed, both for enrolment and for recognition/verification.

D.13 Quality score

If a biometric sample quality score can be derived from a representation then the goal is to maximize this score for all representations. The quality score should quantitatively express the utility of the representation, which is the predicted performance of a biometric sample in a biometric system. The quality score might be dependent on several quality factors, including resolution, contrast and image noise level. Averaged over a larger number of images, the quality score is intended to predict the identification and verification performance of the biometric algorithm used. For a particular pair of iris images from the same eye, it could express the contribution of the pair to the overall predicted performance of the system.

ISO/IEC 29794-6:2015, 6.5 gives guidance and recommendations on how to compute a unified quality score combining several quality metrics for iris records.

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- [3] Netpbm image format¹
- [4] Daugman J., Downing C., *Effect of severe image compression on iris recognition performance*. IEEE Trans. on Information Forensics and Security. 2008 March, **3** (1) pp. 52–61
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- [6] Grother P., Tabassi E., Quinn G.W., Salamon W. *IREX Interoperable Iris Exchange I: Performance of Iris Recognition Algorithms on Standard Images*. NIST Interagency Report 7629, 2009

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