BS ISO/IEC 39794-5:2019



BSI Standards Publication

Information technology — Extensible biometric data interchange formats

Part 5: Face image data

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National foreword

This British Standard is the UK implementation of ISO/IEC 39794-5:2019.

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This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Part 5: Face image data

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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).

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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.

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Introduction

Face images have been used for many decades to verify the identity of individuals. In recent years, digital face images have been used in many applications including human examination as well as computer-automated face recognition. Photographic formats are standardized, e.g., for passports and driver licences. There is also a need for a standard data format for digital face images to enable interoperability. A prominent case where such interoperability is essential is the electronic passport system, where face images are stored for several purposes including Automated Border Control.

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 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 were added, the header data structures were harmonized across all parts of the ISO/IEC 19794 series, and XML encoding was been added in addition to the binary encoding.

In anticipation of the need for additional data elements, and in order to avoid future compatibility issues, the ISO/IEC 39794 series provides standard biometric data interchange formats capable of being extended in a defined way. Extensible specifications in ASN.1 (Abstract Syntax Notation One) and the distinguished encoding rules (DER) of ASN.1 form the basis for encoding biometric data in binary tag-length-value formats. XSDs (XML schema definitions) form the basis for encoding biometric data in XML (eXtensible Markup Language).

This third generation of face image data interchange formats complements ISO/IEC 19794-5:2005 and ISO/IEC 19794-5:2011. 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 to provide a generic face image data format for face recognition applications requiring exchange of face image data. Typical applications are:

— automated face biometric verification (one-to-one comparison) and identification (one-to-many comparison), and

— human verification of a biometric claim by comparison of data subjects against face images, including examination of face images with sufficient detail.

In addition to the data format, this document specifies application specific profiles including scene constraints, photographic properties and digital image attributes like image spatial sampling rate, image size, etc. These application profiles are contained in Annex D.

The structure of the data format in this document is not compatible with the previous generations. However, this new revision addresses, for the first time, a mechanism to maintain future extensions in a backwards- and forwards-compatible manner. This will mean that a parser is able to read data records and understand data items that are formatted according to versions of the standard that are older, the same or newer than the parser is developed to. All newer data items will not disrupt the parsing process and can be ignored. Newer versions of this document will at least include the mandatory data items of the previous standards.

The 3D encoding types 3D point map and range image are not supported by this edition of this document.

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Information technology — Extensible biometric data interchange formats —

Part 5:
Face image data

1 Scope

This document specifies:

— generic extensible data interchange formats for the representation of face 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: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER) — Part 1*

ITU-T Rec. T.81 | ISO/IEC 10918-1, *Information technology — Digital compression and coding of continuous-tone still images — Part 1: Requirements and guidelines*

ISO 11664-2:2007, *Colorimetry — Part 2: CIE standard illuminants*

ISO/IEC 14496-2:2004, *Information technology — Coding of audio-visual objects — Part 2: Visual*

ITU-T Rec. T.800 | 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*

Doc ICAO 9303: *Machine Readable Travel Documents*

W3C Recommendation, *XML Schema Part 1: Structures* (Second Edition), 28 October 2004, http://www.w3.org/TR/xmlschema-1/

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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 39794-1, ISO/IEC 2382-37 and the following apply.

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
1:1 application case
biometric verification

Note 1 to entry: Biometric verification is defined in ISO/IEC 2382-37 as a process of confirming a biometric claim through biometric comparison.

3.2
1:N application case
biometric identification

Note 1 to entry: Biometric identification is defined in ISO/IEC 2382-37 as a process of searching against a biometric enrolment database to find and return the biometric reference identifier(s) attributable to a single individual.

3.3
2D face image
two-dimensional face representation that encodes the luminance and/or colour texture of the face of a capture subject in a given lighting environment

3.4
3D face image
three-dimensional face representation that encodes a surface in a 3D space

3.5
3D vertex
representation using 3D vertices and triangles between these points for coding of a 3D surface

3.6
RGB
colour space designed to encompass most of the colours achievable on CMYK colour printers, but by using red, green and blue primary colours on a device such as a computer display

3.7
anthropometric landmark
landmark on the face used for identification and classification of humans

3.8
landmark code
<anthropometric> two-part code that uniquely defines an anthropometric landmark

3.9
camera to subject distance
CSD
distance between the eyes plane of a capture subject and the and the sensor/image plane of the camera

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3.10
Cartesian coordinate system
3D orthogonal coordinate system

3.11
chin
central forward portion of the lower jaw

3.12
CIE standard illuminant D65
commonly used standard illuminant defined by the International Commission on Illumination (CIE) that is intended to represent average daylight and has a correlated colour temperature of approximately 6500 K

Note 1 to entry: CIE standard illuminant D65 is specified in ISO 11664-2.

3.13
colour image
continuous tone image (3.16) that has more than one channel, each of which is coded with one or multiple bits

3.14
colour space
way of representing colours of pixels in an image

EXAMPLE RGB and YUV colour spaces are typically used in this document.

3.15
common biometric exchange formats framework
CBEFF
data format specifically for exchanging biometric data that provides for the encompassing of any biometric type into a standard format

3.16
continuous tone image
image whose channels have more than one bit per pixel

3.17
crop factor
ratio of the diagonal of the full frame camera (43,3 mm) to that of a selected camera's image sensor

Note 1 to entry: The determination of an appropriate focal length lens for a field of view equivalent to a full frame camera can be made by considering the crop factor.

3.18
crown
top of the head ignoring any hair

3.19
dots per inch
DPI
individual printed dots in a line or column within a span of 25,4 mm (1 inch)

3.20
exposure value
EV
number that represents a combination of a camera's shutter speed and f-number, such that all combinations that yield the same exposure have the same description value

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3.21
eye centre
centre of the line connecting the inner and the outer corner of the eye

Note 1 to entry: The eye centres are the feature points 12.1 and 12.2 as defined in ISO/IEC 14496-2:2004, Annex C.

Note 2 to entry: The inner and the outer corner of the eye are defined by ISO/IEC 14496-2-2:2004: feature points 3.12 and 3.8 for the right eye, and 3.11 and 3.7 for the left eye.

3.22
eye-to-mouth distance
EMD
distance between the face centre and the mouth midpoint

Note 1 to entry: The mouth midpoint is the feature point 2.3 as defined in ISO/IEC 14496-2:2004, Annex C.

3.23
eye visibility zone
EVZ
zone covering a rectangle having a margin to any part of the visible eyeball

Note 1 to entry: The margin is defined in D.1.4.3.3.

3.24
face centre
M
midpoint of the line connecting the two eye centres

3.25
face image kind
category of *face images* (3.27) that satisfy specific requirements

Note 1 to entry: Application specific requirements are specified in one of the application profiles in Annex D.

3.26
facial animation parameter
FAP
standard for the virtual representation, which includes visual speech intelligibility, mood and gesture by using feature points

Note 1 to entry: Visual representation as specified in ISO/IEC 14496-1 and ISO/IEC 14496-2.

3.27
face image
electronic image-based representation of the face of a capture subject

3.28
face portrait
visual representation of the capture subject, which includes the full-frontal part of the head, including hair in most cases, as well as neck and possibly top of shoulders

3.29
face texture
2D sampling face representation that encodes one or a combination of several spectral spatial modulations received by 3D imaging systems of a face in a given lighting system having a 2D coordinate link to the face shape

3.30
feature point
reference point in a face image as used by face recognition algorithms

Note 1 to entry: Commonly referred to as a landmark, an example being the position of the eyes.

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3.31
fish eye
type of distortion where central objects of the image erroneously appear closer than those at the edge

3.32
Frankfurt Horizon
standard plane for orientation of the head defined by a line passing through the right tragion (the front of the ear) and the lowest point of the right eye socket

Note 1 to entry: The Frankfurt Horizon may be hard to define, as it is related to the ear position that may be covered by hair.

Note 2 to entry: The Frankfurt Horizon has been defined in the Frankfurt-am-Main (anthropological) Agreement of 1882.

3.33
greyscale image
continuous tone image (3.16) encoded with one luminance channel

Note 1 to entry: If the luminance channel is coded with 8 bits, the greyscale image is also referred to as a monochrome or black and white image.

3.34
horizontal deviation angle
HD
maximal allowed deviation from the horizontal of the imaginary line between the nose of a capture subject and the lens of the camera

3.35
human examination
process of human comparison of a face image with an individual or another face image through detailed examination of face characteristics and structures for the purposes of biometric verification or identification

3.36
human identification
process of human searching through a list of face images to match against an input image(s)

Note 1 to entry: Also known as one-to-many (1:N) searching.

Note 2 to entry: Identification can be performed by human (experts) as well, and human identification may consider more than biometric data.

3.37
human verification
process of confirming a specific biometric claim by human comparison of a face image with an individual or another face image

Note 1 to entry: Also known as one-to-one (1:1) comparison.

Note 2 to entry: Verification can be performed by human (experts) as well, and human verification may consider more than biometric data.

3.38
implementation under test
IUT
Implementation of a technical system currently tested

3.39
inner region
pixels of a face image carrying data of the central region of a face

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3.40
inter-eye distance
IED
length of the line connecting the eye centres of the left and right eye

3.41
issuer
organization that issues Machine Readable Travel Documents (MRTDs)

3.42
lower camel-case notation
naming convention in which compound words are joined together without spaces, where the first letter of the entire word is lowercase, but the first letter of subsequent words is uppercase

3.43
magnification distortion
image imperfection where the degree of magnification varies with the distance from the camera and the depth of the face

3.44
modus
manner in which a particular property is acquired

3.45
near infrared
section of infrared band with wavelength from 780 nm to 3000 nm

3.46
outer region
pixels of a face image outside of the inner region

3.47
photo booth
automated system for digitally capturing 2D images in either public or office environments

Note 1 to entry: A photo booth encloses the subject in a highly-controlled lighting environment and consists of a camera, lighting and peripheral devices such as printers. It has entrances on one or both sides with reflective curtains protecting against ambient light.

3.48
photo kiosk
semi-automated system for digitally capturing 2D images in an office-environment

Note 1 to entry: A photo kiosk consists of camera and lighting and usually has a separate panel placed behind the subject to provide the required background but is otherwise open.

3.49
pixel
picture element on a two-dimensional array that comprises an image

3.50
pixel per inch
PPI
individual pixels in a line or column of a digital image within a span of 25,4 mm (1 inch)

3.51
presentation attack
presentation of an artefact or human characteristic to the biometric capture subsystem in a fashion that could interfere with the intended policy of the biometric system

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3.52
presentation attack detection
PAD
automated determination of a presentation attack

3.53
radial distortion
image imperfection where the degree of magnification varies with the distance from the optical axis

3.54
red eye effect
red glow from a subject's eye caused by light from flash reflecting from blood vessels behind the retina

3.55
subject
individual who is to be displayed on the face portrait

Note 1 to entry: If the face portrait is part of a Machine Readable Travel Document (MRTD), this individual is intended to be the holder of the MRTD.

3.56
upper camel-case notation
naming convention in which compound words are joined together without spaces and the first letter of every word is uppercase

3.57
wavelength
distance between repeating units of a wave pattern

Note 1 to entry: Commonly designated by the Greek letter lambda (λ).

3.58
white light
apparently colourless light on human perception

EXAMPLE Ordinary daylight, standard lights as D50, D65, etc.

Note 1 to entry: For many purposes it is assumed that white light contains all wavelengths of the visible spectrum at equal intensity based on human perception. Strong deviations from equal intensity usually lead to deviations in the perception of colours.

4 Abbreviated terms

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

ABC	Automated Border Control
CCD	charge-coupled device
CMOS	complementary metal-oxide-semiconductor
CSD	camera to subject distance
DOVID	diffractive optically variable image device
DPI	dots per inch
EMD	eye-to-mouth distance

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EV	exposure value
EVZ	eye visibility zone
FAP	facial animation parameter
FH	Frankfurt Horizon
HD	horizontal deviation angle
ICAO	International Civil Aviation Organization
IED	Inter-eye distance
JPEG	image compression standard specified as ISO/IEC 10918; the JPEG baseline standard was published as ITU-T Rec. T.81 | ISO/IEC 10918-1
JPEG2000	image compression standard specified as ISO/IEC 15444; the JPEG2000 baseline standard was published as ITU-T Rec. T.800 | ISO/IEC 15444-1
LDS	logical data structure as defined in ICAO Doc 9303
M	face centre
MP	intensity measurement pattern side length
MRTD	machine readable travel document, the term also includes electronic MRTD's, electronic machine readable travel document using a contactless integrated circuit
MTF	modulation transfer function
MTF20	highest spatial frequency where the MTF is 20 % or above
NIR	near infrared
PPCM	pixel per centimetre
PPI	pixel per inch
PNG	portable network graphics format specified as ISO/IEC 15948
RFID	radio-frequency identification
RGB	red green blue colour representation
SFR	spatial frequency response
SNR	signal to noise ratio
sRGB	standard RGB colour space created for use on monitors, printers and the Internet using the ITU-R BT.709 primaries

5 Conformance

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

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

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

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— application profile specific compliance specifications given in Annex C.4.

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 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.

A system that uses BDBs is conformant to this document if it can read, and use for the purpose intended by that system, all BDBs 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 BDBs 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

The recorded image data shall appear to be the result of a capture process of a face. 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, which corresponds to the upper right-hand side of the forehead from the perspective of the capture subject. The x-coordinate (horizontal) position shall increase positively from the origin to the right side of the image (i.e. left-hand forehead). The y-coordinate (vertical) position shall increase positively from the origin to the bottom of the image.

7 Abstract data elements

7.1 Overview

7.1.1 Content and notation

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

The presence of data elements is specified in Annex A. Certain data elements are optional. Such data elements need not be included in a BDB. An optional data element may be omitted altogether from the encoding.

Application profiles as defined in Annex D may further restrict the presence of data elements. Such profiles may make optional elements mandatory, and they may exclude optional elements.

In an ASN.1 module, optional data elements are marked with the keyword OPTIONAL. When such an element is not present, then the tag, length and value octets of this data element are omitted from the tagged binary encoding.

A data element in an XML schema definition is optional if the value of its minOccurs attribute is 0. When such an element is not present, the opening and closing tags as well as the value of this data element are omitted from the XML encoding.

If all child elements of a data element are optional, this data element shall be marked optional as well.

Type names are in upper camel-case notation derived from subclause titles in this clause. Element names are in lower camel-case notation derived from these subclause titles. If the generic name starts with a number, then this component is set to the end of the base name. In the XSD, type names will end with the word “Type”.

EXAMPLE 1 The Image Colour Space element has the encoding name imageColourSpace and the type ImageColourSpace (in ASN.1) and ImageColourSpaceType (in XML).

EXAMPLE 2 An element value with the abstract name colour coded light has the value colourCodedLight. An element value with the abstract name 48 bit RGB has the encoding value rgb48Bit.

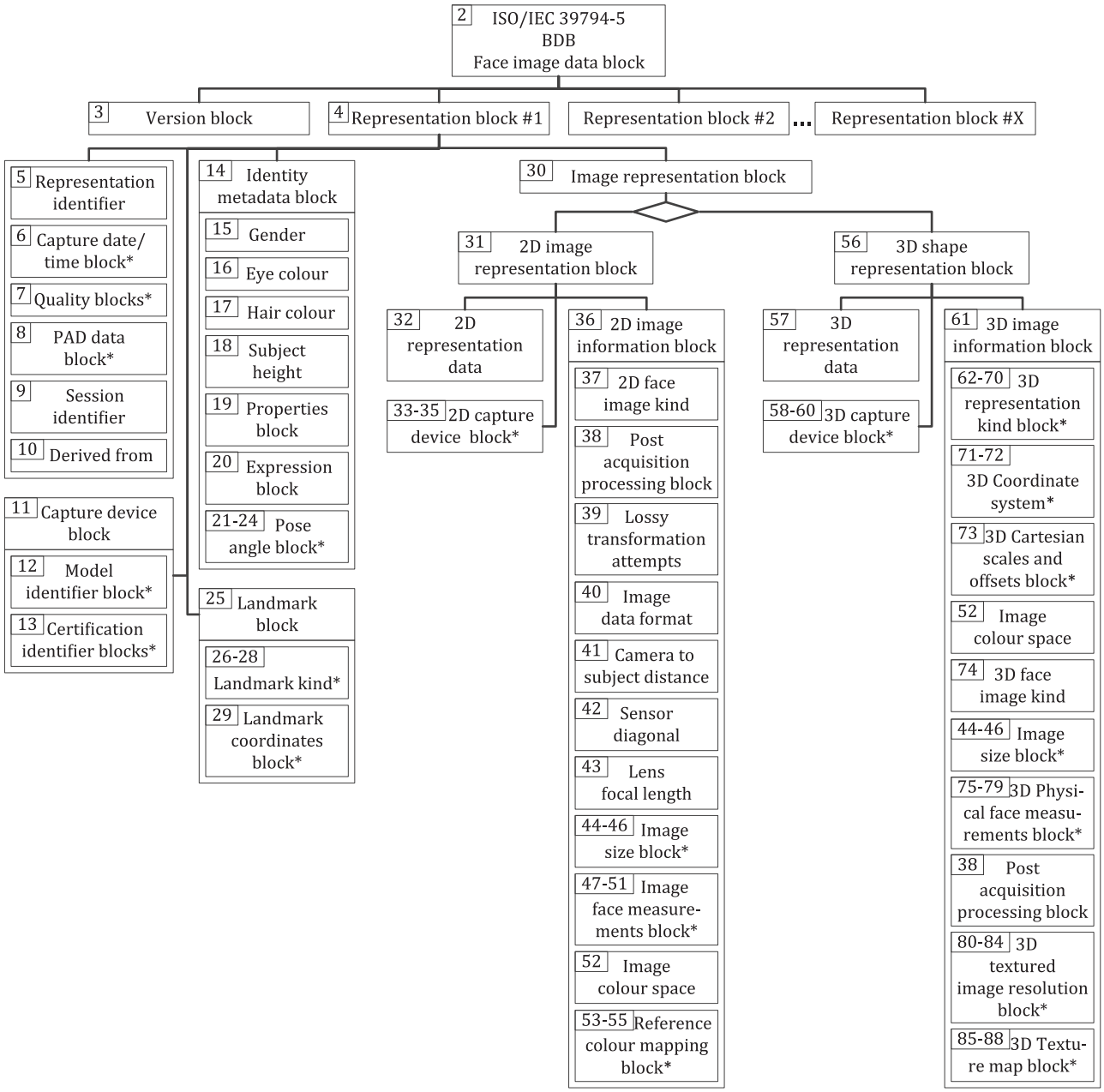
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7.1.2 Structure overview

The order of the abstract data elements in 7.2 and beyond is derived from traversing the tree in Figure 1 from left to right, depth first. A formal description of the structure is given in Annex A.1 for ASN.1 and in Annex A.2 for the XML encoding of these abstract data elements.



Key

* elements which can be divided in sub-elements, not shown in this Figure

◇ Exclusive Or (XOR), one, and only one, option shall be chosen

n denotes that this element is defined in Clause 7.n

The Figure has been manually generated, its content is informative. The normative structure is given in A.1 for ASN.1 and A.2 for XML.

Figure 1 — Face image data block

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7.1.3 Data conventions

For value measurement the following units are used:

— physical measurement: millimetres;

— image measurement: pixels;

— left/right: from perspective of the subject.

Unless otherwise specified, all other numeric values are unsigned integer quantities.

The conversion of a numeric value to integer is given by rounding down if the fractional portion is less than 0,5 and rounding up if the fractional value is greater than or equal to 0,5.

The absence of an optional element means that the encoder does not provide any statement about the value of the element.

7.2 Face image data block

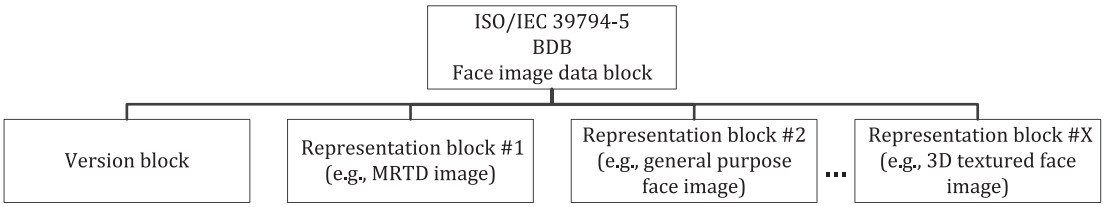


Figure 2 — Example of embedding multiple representations in the same Face image data block

Abstract values: None

Contents: Each BDB shall pertain to a single subject and shall contain one or more representations of a human face. Together with the Version block, each BDB can contain one or more geometric representations in Representation blocks. The record structure is depicted in Figure 2.

7.3 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.

If a BDB contains representations encoded using different versions of an extensible biometric data interchange format, then the version number of the most recent version of the encoding versions shall be used.

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7.4 Representation block

Abstract values: None.

Contents: A Representation block consists of a unique Representation identifier characterizing this Representation block, an Image representation block, a Capture date/time block, Quality blocks, a PAD data block, a Session identifier, an identifier to define a relationship to another record, called Derived from, a Capture device block, a Identity metadata block describing discernible characteristics of the subject, and the Landmark blocks. The structure of this element is shown in Figure 1.

Multiple face image representations of the same biometric data subject may be described in the same Face image data block. This is accomplished by including multiple Representation blocks. Face image representations containing 2D data may be combined with face image representations containing 3D data.

EXAMPLE The structure of a possible storage of Respresentaton blocks containing 2D and 3D data is illustrated in Figure 2.

7.5 Representation identifier

Abstract values: Integer.

Contents: This element shall obtain a unique identifier for the Representation block. Each representation shall have its unique Representation identifier.

NOTE Unlike other parts of the ISO/IEC 39794 series, this document requires Representation identifiers to link processed data to its original source.

7.6 Capture date/time block

Abstract values: See Capture date/time block in ISO/IEC 39794-1.

Contents: The Capture date/time block shall indicate when the capture of this representation started in Coordinated Universal Time (UTC).

7.7 Quality blocks

Abstract values: See Quality blocks in ISO/IEC 39794-1.

Contents: This element contains information on the biometric sample quality.

7.8 PAD data block

Abstract values: See PAD data block in ISO/IEC 39794-1.

Contents: This element shall convey the mechanism used in biometric presentation attack detection and the results of the presentation attack detection mechanism.

7.9 Session identifier

Abstract values: Integer.

Contents: This element shall map the Representation block to the photo session where the face image was recorded.

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7.10 Derived from

Abstract values: Integer.

Contents: This element shall denote interdependencies when multiple representations are stored in a Face image data block. This is of particular interest in the case where post-processing has been used but may be used in case of all other image types, too. The value shall be the Representation identifier number of the original representation.

To give an example for an application of this specification, assume that there are two Representations in the overall record. Their identifiers are 1 and 2. The first representation has been post-processed and resulted in the second representation. Then, the second representation shall have the Derived from element set to 1.

7.11 Capture device block

Abstract values: See Capture device block in ISO/IEC 39794-1.

Contents: The Capture device block contains the Model identifier block and the Certification identifier blocks.

7.12 Model identifier block

Abstract values: See Model identifier block in ISO/IEC 39794-1.

Contents: The Model identifier block shall identify the biometric organization that manufactures the product that created the BDB. It shall carry a CBEFF biometric organization identifier (see ISO/IEC 39794-1). Additionally, it shall identify the product type that created the BDB. It shall be assigned by the registered product manufacturer or other approved registration authority (see ISO/IEC 39794-1).

7.13 Certification identifier blocks

Abstract values: See Certification identifier blocks in ISO/IEC 39794-1.

Contents: This document does not contain details of certification schemes.

NOTE Currently, no certification schemes are available for this document.

7.14 Identity metadata block

Abstract values: For the structure see Figure 1.

Contents: The Identity metadata block is intended to describe properties of the subject pictured in the image. The Identity metadata block consists of the Gender, Eye colour, Hair colour, and Subject height elements, the Properties block, the Expression block, and the Pose angle block.

If all elements of this element are absent, the element itself shall be absent, too.

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7.15 Gender

Abstract values: The value of this element shall be one of the following:

— unknown;

— other;

— male;

— female.

Contents: The Gender element shall represent the gender of the subject.

7.16 Eye colour

Abstract values: The value of this element shall be one of the following:

— unknown;

— other;

— black;

— blue;

— brown;

— grey;

— green;

— hazel;

— multi-coloured;

— pink.

Contents: The Eye colour element shall represent the colour of the irises of the eyes. If the eyes have different colours, then the colour of the right eye shall be encoded.

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7.17 Hair colour

Abstract values: The value of this element shall be one of the following.

Contents:
- unknown;
- other;
- bald;
- black;
- blonde;
- brown;
- grey;
- white;
- red;
- known coloured (it is known that the hair colour has been changed from the natural one of that capture subject).

Contents: The Hair colour element shall represent the colour of the hair of the subject.

7.18 Subject height

Abstract values: Integer.

Contents: The Subject height element shall represent the height of the subject in millimetres. The minimum value for this element shall be 1 mm and the maximum value shall be 65535 mm.

NOTE This value in most cases can only be used as a rough estimate of the subject height. Shoes, age, and even time of the day influence this measure.

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7.19 Properties block

Abstract values: This element contains one or several of the following elements:

— glasses;

— moustache;

— beard;

— teeth visible;

— pupil or iris not visible (e.g. either or both eyes closed or half closed);

— mouth open;

— left eye patch;

— right eye patch;

— dark glasses (medical);

— biometric absent (conditions which could impact landmark detection);

— head coverings present (e.g., hats, scarves, toupees).

Contents: The Properties block indicates which properties are present. There may be restrictions for different Face image kinds (see the profiles in Annex D). Each element may be true, false or absent. False elements do not need to be listed unless those elements are mandatory.

7.20 Expression block

Abstract values: This element contains one or several of the following items:

— neutral (non-smiling) with both eyes open and mouth closed;

— smile;

— raised eyebrows;

— eyes looking away from the camera;

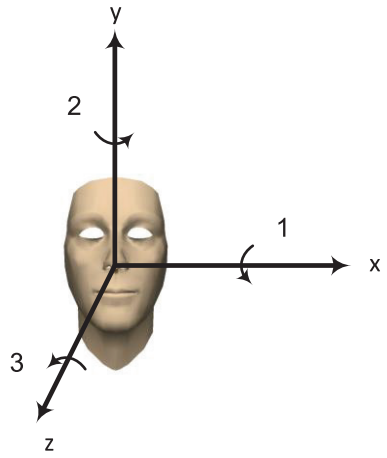
— squinting;

— frowning.

Contents: The Expression block indicates which expressions are shown. Each element may be true, false or absent. False elements do not need to be listed unless those elements are mandatory. Neutral and smile shall not be both true for the same image.

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7.21 Pose angle block



Key

1 pitch (P)

2 yaw (Y)

3 roll (R)

The three elements together define the pose (Y, P, R).

Figure 3 — Definition of pose angles with respect to the frontal view of the subject

Abstract values: The Pose angle block contains Angle blocks for yaw, pitch, and roll.

Contents: The Pose angle block shall represent the estimated or measured pose of the subject in the image.

The angles encoded in this element are:

Yaw angle block (Y): Rotation about the vertical (y) axis. The yaw angle Y is the rotation in degrees about the y-axis (vertical axis) shown in Figure 3. Frontal poses have a yaw angle of 0°. Positive angles represent faces looking to their left (a counter-clockwise rotation around the y-axis).

Pitch angle block (P): Rotation about the horizontal side-to-side (x) axis. The pitch angle P is the rotation in degrees about the x-axis (horizontal axis) shown in Figure 3. Frontal poses have a pitch angle of 0°. Positive angles represent faces looking down (a counter-clockwise rotation around the x-axis).

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Roll angle block (R): Rotation about the horizontal back to front (z) axis. The roll angle R is the rotation in degrees about the z-axis (the horizontal axis from front to back) shown in Figure 3. Frontal poses have a roll angle of 0°. Positive angles represent faces tilted toward their right shoulder (counter-clockwise rotation around the z-axis). A roll angle of 0° denotes that the left and right eye centres have identical y coordinates.

The angles are defined relative to the frontal pose of the subject, which has angles (Y = P = R = 0) as shown in Figure 3. The frontal pose is defined by the Frankfurt Horizon as the xz plane and the vertical symmetry plane as the yz plane with the z axis oriented in the direction of the face sight. Examples are shown in Figure 4.

As order of the successive rotation around the different axes does matter, the encoded rotation angle shall correspond to an order of execution starting from the frontal view. This order shall be given by roll (about the front axis), then pitch (about the horizontal axis) and finally yaw (about the vertical axis). The (first executed) roll transformation will therefore always be in the image xy plane.

From the point of view of executing a transformation from the observed view to a frontal view, the transformation order will therefore be in the opposite order: Yaw, pitch, and then roll. The encoded angles are from the frontal view to the observed view. The conversion to integer is specified in 7.1.



(Y,P,R) = (0, 0, 0) (+45, 0, 0) (-45, 0, 0) (0, -45, 0) (0, +45, 0) (0, 0, -45) (0, 0, 45)

Figure 4 — Examples of pose angles in the form (Y, P, R)

7.22 Angle data block

Abstract values: Angle value and Angle uncertainty.

Contents: The Angle data block element contains an Angle value and its corresponding Angle uncertainty.

7.23 Angle value

Abstract values: Integer, the minimum value is –180, the maximum value is 180.

Contents: The Angle value is given by Tait-Bryan angles (in degrees).

7.24 Angle uncertainty

Abstract values: The minimum value of an Angle uncertainty variable is 0, the maximum value is 180.

Contents: The Angle uncertainty represents the expected degree of uncertainty of the associated pose angle. The more uncertain, the value of the uncertainty shall become larger. The Angle uncertainty allows storing an uncertainty or tolerance value for an angle. The true angle should be in a range of Angle value ± Angle uncertainty. If the associated pose angle is absent, the Angle uncertainty for this angle shall be absent, too.

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7.25 Landmark block

Abstract values: None.

Contents: The Landmark block specifies the type, code and position of landmarks in the face image. If the Landmark blocks element is present, it shall contain at least one Landmark block. A Landmark block consists of the Landmark kind element and the Landmark coordinates block. The structure of this element is shown in Figure 1.

Landmarks can be specified as MPEG-4 feature points as given by ISO/IEC 14496-2:2004, Annex C or as anthropometric landmarks. The description of the anthropometric landmarks[2] and their relation with the set of MPEG4 feature points is discussed in Table 2.

7.26 Landmark kind

Abstract values: MPEG4 feature point or anthropometric landmark.

Contents: The Landmark kind shall either be MPEG4 feature point or anthropometric landmark. The Landmark code shall specify the landmark that is stored in the Landmark block element. The MPEG4 feature points are extended by eye and nostril landmarks

References to right and left shall be taken from the perspective of the subject contained within an image. References to right shall mean the right side of the body from the perspective of the subject. References to the left shall mean the left side of the body from the perspective of the subject.

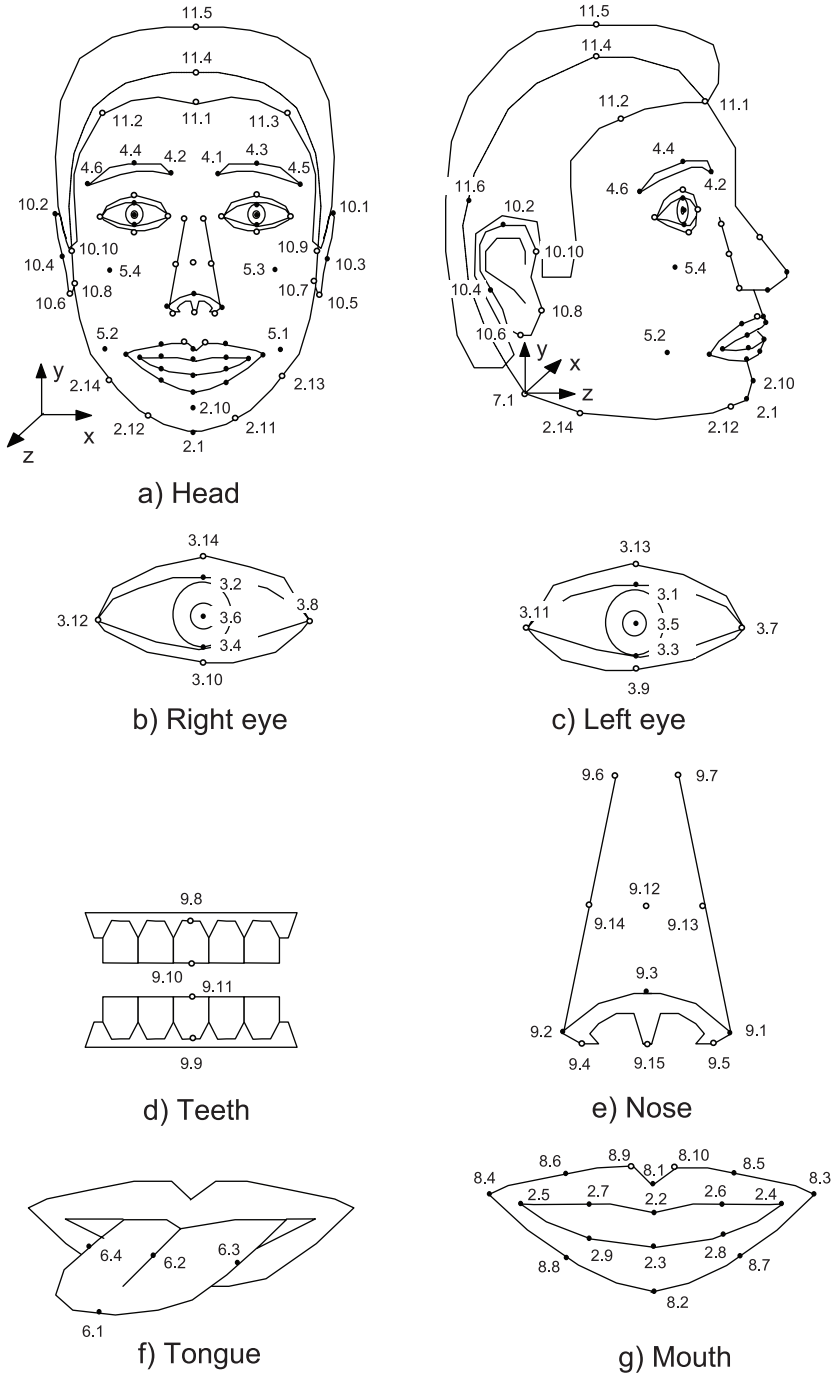
7.27 MPEG4 feature point

Abstract values: See Figure 5 and Figure 6.

Contents: Figure 5 denotes the landmark codes associated with feature points as given by ISO/IEC 14496-2:2004, Annex C. Each landmark can be written in the form A.B using a major (A) and a minor (B) value. Eye and nostril landmarks are contained as an addition to the MPEG4 feature points.

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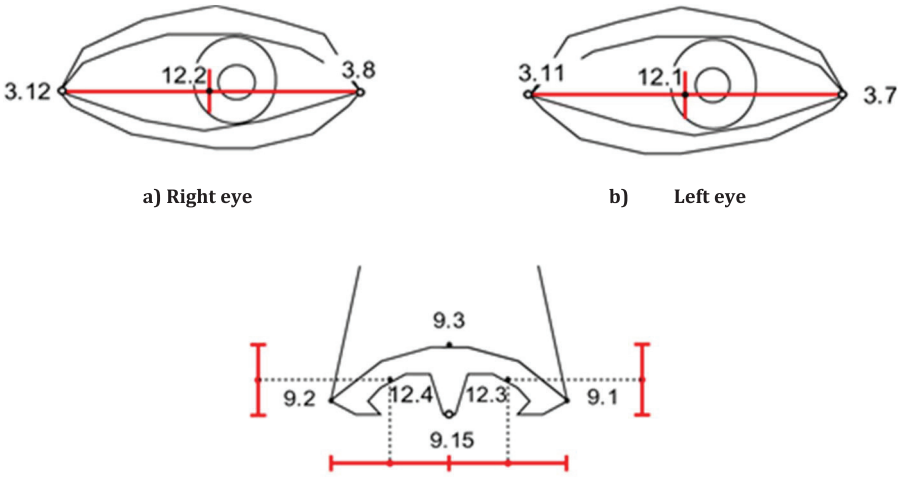
Key

- ● feature points affected by face animation parameters (FAPs) as specified in ISO/IEC 14496-2
- ○ other feature points

Figure 5 — Feature points as specified in ISO/IEC 14496-2

The eye centre landmarks 12.1 (left) and 12.2 (right) are defined to be the horizontal and vertical midpoints of the eye corners (3.7, 3.11) and (3.8, 3.12) respectively. The left nostril centre landmark 12.3 is defined to be the midpoint of the nose landmarks (9.1, 9.15) in the horizontal direction and (9.3, 9.15) in the vertical direction. Similarly, the right nostril centre landmark 12.4 is defined to be the midpoint of the nose landmarks (9.2, 9.15) in the horizontal direction and (9.3, 9.15) in the vertical direction. Both the eye centre and nostril centre landmarks are shown in Figure 6 and values given in Table 1.

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a) Right eye

b) Left eye

c) Nostrils

Key

- ● feature points affected by FAPs
- ○ other feature points

The landmarks 12.1, 12.2, 12.3, and 12.4 are defined to be the midpoints of MPEG features.

Figure 6 — Eye and nostril centre landmarks

Table 1 — Eye and nostril centre landmark codes

Centre landmark	Midpoint of landmarks		Landmark code
Left eye	3.7, 3.11		12.1
Right eye	3.8, 3.12		12.2
Left nostril	Horizontal	Vertical	12.3
	9.1, 9.15	9.3, 9.15	
Right nostril	Horizontal	Vertical	12.4
	9.2, 9.15	9.3, 9.15	

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7.28 Anthropometric landmark

Abstract values: See Table 2.

Contents: Anthropometric landmarks denote feature points that are used in forensics and anthropology for recognition of individuals via two face images or image and skull over a long time. They also allow specification of points that are in use by criminal examiners and anthropologists[2].

Figure 7 and Table 2 show the definition of the Anthropometric landmarks. The set of points represents the craniofacial landmarks of the head and face. The latter are used in forensics for “face to face” and “skull to face” identification. Some of these points have MPEG 4 counterparts, others not.

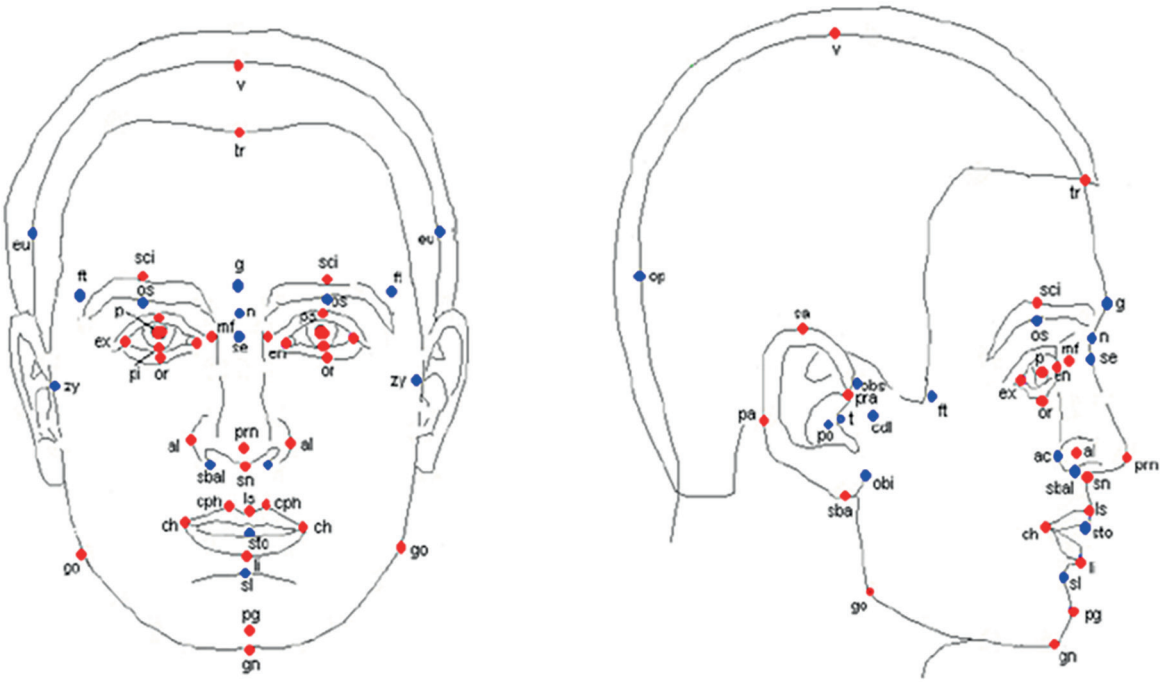
There are three different possibilities to encode an Anthropometric landmark:

Firstly, each Anthropometric landmark may be notated in the form A.B. A specifies the global landmark of the face to which this landmark belongs such as nose, mouth, etc. B specifies the particular point. In case a landmark has two symmetrical entities (left and right) the right entity always has a greater and even minor code value. Hence, all landmarks from the left part of the face have odd minor codes, and from the right part – even minor codes.

Secondly, each Anthropometric landmark may be notated by its name. In case a landmark has two symmetrical entities (left and right) a "left" or "right" shall be added to the names in Table 2.

Thirdly, each Anthropometric landmark may be notated by its point identifier. In case a landmark has two symmetrical entities (left and right) a "left" or "right" shall be added to the names in Table 2.

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Key

- landmarks without MPEG4 counterpart
- landmarks with MPEG4 counterpart

Figure 7 — Anthropometric landmarks

Table 2 — Definitions of the anthropometric landmarks

Anthropometric landmark point identifier	Anthropometric landmark point name	MPEG4	Anthropometric landmark name	How to point
v	1.1	11.4	vertex	The highest point of head when the head is oriented in Frankfurt Horizon
g	1.2		glabella	The most prominent middle point between the eyebrows
op	1.3		opisthocranion	Situated in the occipital region of the head is most distant from the glabella
eu	1.5, 1.6		eurion	The most prominent lateral point on each side of the skull in the area of the parietal and temporal bones
ft	1.7, 1.8		frontotemporale	The point on each side of the fore-head, laterally from the elevation of the linea temporalis
tr	1.9	11.1	trichion	The point on the hairline in the mid-line of the forehead
zy	2.1, 2.2		zygion	The most lateral point of each of the zygomatic
go	2.3,2.4	2.13, 2.14	gonion	The most lateral point on the mandib-ular angle close to the bony gonion

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Table 2 *(continued)*

Anthropometric landmark point identifier	Anthropometric landmark point name	MPEG4	Anthropometric landmark name	How to point
sl	2.5		sublabiale	Determines the lower border of the lower lip or the upper border of the chin
pg	2.6	2.10	pogonion	The most anterior midpoint of the chin, located on the skin surface in the front of the identical bony landmark of the mandible
gn	2.7	2.1	menton (or gnathion)	The lowest median landmark on the lower border of the mandible
cdl	2.9, 2.10		condylion laterale	The most lateral point on the surface of the condyle of the mandible
en	3.1, 3.2	3.11, 3.8	endocanthion	The point at the inner commissure of the eye fissure
ex	3.3, 3.4	3.7, 3.12	exocanthion (or ectocanthion)	The point at the outer commissure of the eye fissure
p	3.5, 3.6	3.5, 3.6	centre point of pupil	Is determined when the head is in the rest position and the eye is looking straight forward
or	3.7, 3.8	3.9, 3.10	orbitale	The lowest point on the lower margin of each orbit
ps	3.9, 3.10	3.1, 3.2	palpebrale superius	The highest point in the midportion of the free margin of each upper eyelid
pi	3.11, 3.12	3.3, 3.4	palpebrale inferius	The lowest point in the midportion of the free margin of each lower eyelid
os	4.1, 4.2		orbitale superius	The highest point on the lower border of the eyebrow
sci	4.3, 4.4	4.3, 4.4	superciliare	The highest point on the upper border in the midportion of each eyebrow
n	5.1		nasion	The point in the middle of both the nasal root and nasofrontal suture
se	5.2		sellion (or subnasion)	Is the deepest landmark located on the bottom of the nasofrontal angle
al	5.3, 5.4	9.1, 9.2	alare	The most lateral point on each alar contour
prn	5.6	9.3	pronasale	The most protruded point of the apex nasi
sn		9.15	subnasale	The craniometric point at the base of the nasal (nose) spine
sbal			subalare	
ac		9.1, 9.2	alar curvature (or alar crest) point	The nasal alar crest
mf		9.6, 9.7	maxillofrontale	
cph		8.9, 8.10	christa philtra landmark	The point on the crest of the philtrum, the vertical groove in the median portion of the upper lip, just above the vermillion border (sharp demarcation between the lip and the adjacent normal skin)

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Table 2 *(continued)*

Anthropometric landmark point identifier	Anthropometric landmark point name	MPEG4	Anthropometric landmark name	How to point
ls		8.1	labiale (or labrale) superius	The mid point of the vermillion border of the upper lip
li		8.2	labiale (or labrale) inferius	The mid point of the vermillion border of the lower lip
ch		8.3, 8.4	cheilion	The outer corner of the mouth where the outer edges of the upper and lower vermillions meet
sto			stomion	The median point of the oral slit when the lips are closed
sa		10.1, 10.2	superaurale	The furthermost point of the ear lobe when measured from the sba landmark
sba		10.5, 10.6	subaurale	The lowest point on the inferior (lower) border of the ear lobule when the subject is looking straight ahead
pra		10.9, 10.10	preaurale	The point between obs and abi opposite to pa
pa			postaurale	The most posterior point on the free margin of the ear
obs		10.3, 10.4	otobasion superius	The highest point of attachment of the external ear to the head
obi			obotasion inferius	The lowest point of attachment of the external ear to the head
po			porion (soft)	The central point on the upper margin of the external auditory meatus (passage in the ear)
t			tragion	A cephalometric point in the notch just above the tragus (small tongue-like projection of the auricular cartilage) of the ear

7.29 Landmark coordinates block

Abstract values: None.

Contents: The Landmark coordinates block shall contain the coordinates of the associated landmark in the 2D Cartesian coordinate system (in case of 2D image representation block existence), in a Coordinate texture image block, or in a 3D Cartesian coordinate system (in case of 3D image representation block existence).

In 2D Image representation blocks, the Z coordinate of the Cartesian coordinate system is not used. This element shall then contain the horizontal and vertical position of the associated landmark. They are measured in pixels with values from 0 to width-1 and from 0 to height-1. The Coordinate texture image block consists of the two integer values uInPixel and vInPixel. In 3D Shape representation blocks, the X, Y, and Z coordinates are mandatory and defined in the 3D Cartesian coordinate system. The X, Y, and Z coordinates are non-negative integers. The landmarks are converted to metric Cartesian coordinates using the Cartesian scales and offsets block. The error of the Z coordinate of an anthropometric landmark location should be no greater than 3 mm. The point shall withstand from the nearest point on the surface no further than 3 mm.

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7.30 Image representation block

Abstract values: Either 2D image representation block, or 3D shape representation block.

Contents: The Image representation block contains the image data and metadata. It is either a 2D image representation block or a 3D shape representation block.

7.31 2D image representation block

Abstract values: None.

Contents: The 2D image representation block contains the 2D representation data, the 2D image information block, and the 2D capture device block.

7.32 2D representation data

Abstract values: Octet string.

Contents: The 2D representation data element shall contain the encoded image data in accordance with the value of the Image data format element.

7.33 2D capture device block

Abstract values: None.

Contents: The 2D capture device block consists of the 2D capture device spectral block and the 2D capture device technology identifier.

7.34 2D capture device spectral block

Abstract values: The possible values are:

— near infrared;

— thermal;

— white light.

Contents: Many different types of capture devices work in the near infrared, thermal, or white light spectral range. The 2D capture device spectral block indicates whether the capture device technology uses one or more of these spectral ranges.

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7.35 2D capture device technology identifier

Abstract values: The possible values are:

— unknown;

— static photograph from an unknown source;

— static photograph from a digital still-image camera;

— static photograph from a scanner;

— video frame(s) from an unknown source;

— video frame(s) from an analogue video camera;

— video frame(s) from a digital video camera.

Contents: The 2D capture device technology identifier shall indicate the device technology used to acquire the captured biometric sample.

7.36 2D image information block

Abstract values: None.

Contents: The 2D image information block element is intended to describe digital properties of the 2D representation data.

The 2D image information block consists of the Image data format, the 2D face image kind, the Post-acquisition processing block, the Lossy transformation attempts element, the Camera to subject distance, the Sensor diagonal, the Lens focal length, the Image size block, the Image face measurements block, the Image colour space element, and the Reference colour mapping block. The structure of this element is shown in Figure 1.

7.37 2D face image kind

Abstract values: See Table 3 for a list of allowed 2D face image kinds and their normative requirements. Other application specific image types may be added in the future.

Contents: The 2D face image kind element shall represent the type of the face image stored in the 2D representation data. There are several types according to the chosen application specific profile (see Annex D), additional profiles may be included in future versions of this document.

Table 3 — 2D face image kinds

Value	Definition and normative requirements
MRTD	Annex D.1
General purpose	Annex D.2

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7.38 Post acquisition processing block

Abstract values: The values of this block shall be one or more of the following:

— rotated (in- plane);

— cropped;

— down-sampled;

— white balance adjusted;

— multiply compressed;

— interpolated;

— contrast stretched;

— pose corrected;

— multi view image;

— age progressed;

— super-resolution processed;

— normalised.

There may be restrictions on the allowed values by the choice of the 2D face image kind.

Contents: This element contains notifications on potential post acquisition processing steps.

While the alteration of face image data is discouraged, there are cases when no alternative may exist:

— Legacy database of ¾ frontal face images which shall be rotated to full frontal prior to biometric comparison.

— From a frontal image artificial non-frontal face images are automatically generated at predetermined non-frontal poses (multi-view images) using an implicit head model or similar. These images can be beneficial during the comparison process or a manual review process as they show a more similar pose than the original frontal image.

— A single image is to be age progressed and used for verification of a passport holder.

— A short video stream is super-resolved to a single face image for comparison against a watch list.

The Post acquisition processing block allows the specification of the kind of post processing that has been applied to the original captured image.

On the one hand a captured image might need some post-processing so that the resulting representation conforms to the requirements of this document. On the other hand, these processing steps should be minimal and not distort the characteristics of the original image.

7.39 Lossy transformation attempts

Abstract values: Unknown, 0, 1, more than 1.

Contents: This element counts the number of previous lossy transformation steps.

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7.40 Image data format

Abstract values: The values shall be specified according to Table 4.

Contents: The Image data format denotes the encoding type of the 2D representation data and of the 3D texture map.

For lossless compression PNG or JPEG2000 lossless shall be used. For lossless representation of images using more than 8 bits per channel PNG or JPEG2000 lossless shall be used. For lossy representation of images using more than eight bit per channel JPEG2000 shall be used. For an encoding in Netpbm portable binary the image formats P5 (grey, PGM) and P6 (colour, PPM) shall be used.

Table 4 — Image data format codes

Value	Specified in
unknown	
other	
jpeg	ITU-T Rec. T.81 | ISO/IEC 10918-1 and Reference [3]
jpeg2000 lossy	ISO/IEC 15444-1
jpeg2000 lossless	
png	ISO/IEC 15948
pgm	Reference [33]
ppm	Reference [34]

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If the Image data format value is unknown or other or a later-version extension code, then the Image size block (with width and height) shall be included.

In the event that a greyscale face 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, formatted as ASCII characters in decimal;
6. any Whitespace (blanks, TABs, CRs, LFs);
7. the maximum grey value (Maxval), formatted as ASCII characters in decimal – the value shall be smaller than 256, and larger 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 face image shall be encoded in a P5 format.

In the event that a colour face 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, formatted as ASCII characters in decimal;
6. any Whitespace (blanks, TABs, CRs, LFs);
7. the maximum channel value (Maxval), formatted as ASCII characters in decimal – the value shall be smaller than 256, and larger 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 face image shall be encoded in a P6 format.

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7.41 Camera to subject distance

Abstract values: Integer.

Contents: The Camera to subject distance (CSD) element contains the camera to subject distance of the photographical setup used for capturing the photo in millimetres. The maximum CSD to be encoded is 50000 mm. All larger distances shall by encoded using that maximum value.

7.42 Sensor diagonal

Abstract values: Integer.

Contents: The Sensor diagonal element contains the diagonal length of the camera sensor used for capturing the photo in millimetres. The maximum Sensor diagonal to be encoded is 2000 mm. All larger distances shall by encoded using that maximum value. If a zoom lens is used, this data element shall encode the actual focal length used to capture the image.

Figure 8 illustrates the relative sizes of some commonly available image sensors. Table 5 provides the approximate widths, heights, areas, diagonals, and crop factors for these sensors. The dimensions in Table 5 are approximates and serve as examples.

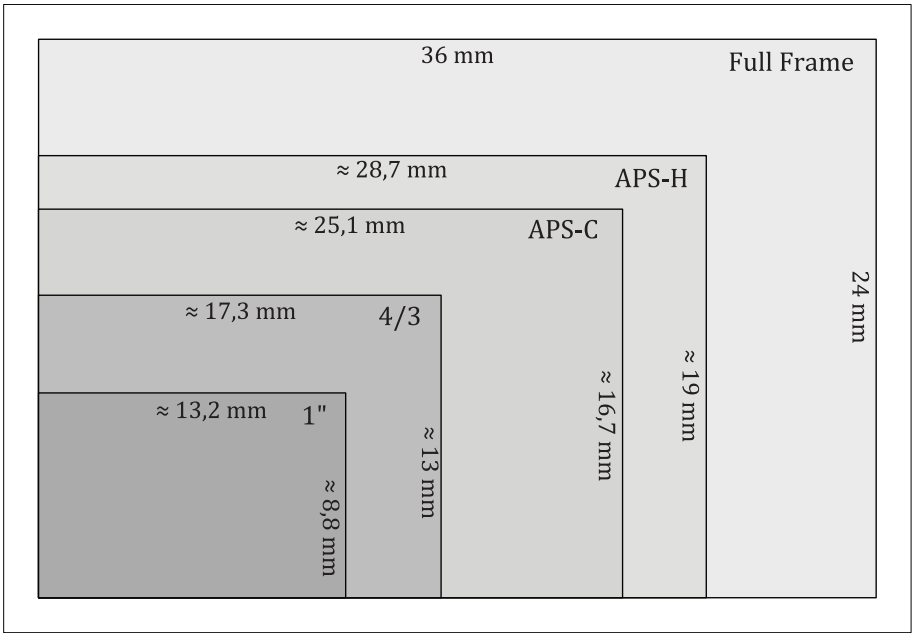


Figure 8 — Typical sensors and their relation in size to the traditional full frame

It might be noted that, by gathering more light, a larger image sensor will provide typically lower image noise, and a fixed focal length lens will generally provide a higher image quality than a zoom lens of the same focal length. Moreover, by using a fixed focal length lens, the problem of inadvertent change to the zoom ratio (i.e., the field of view) can be avoided.

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Table 5 — Typical image sensor sizes and corresponding crop factors

Sensor type	Width (mm)	Height (mm)	Area (mm^2)	Diagonal (mm)	Crop factor
Full frame	36	24	864	43,3	1
APS-H	28,7	19	545	34,4	1,26
APS-C	25,1	16,7	419	30,1	1,44
Four thirds system (4/3)	17,3	13	225	21,6	2,00
1 inch (1")	13,2	8,8	116	15,9	2,73

7.43 Lens focal length

Abstract values: Integer.

Contents: The Lens focal length element contains the focal length of the camera lens used for capturing the photo in millimetres. The maximum Lens focal length to be encoded is 2000 mm. All larger distances shall by encoded using that maximum value.

7.44 Image size block

Abstract values: None.

Contents: The Image size block consists of the Width and the Height element.

7.45 Width

Abstract values: Integer.

Contents: The Width element shall specify the number of pixels of the 2D representation data in the horizontal direction.

7.46 Height

Abstract values: Integer.

Contents: The Height element shall specify the number of pixels of the 2D representation data in the vertical direction.

7.47 Image face measurements block

Abstract values: None.

Contents: For specific application domains different minimal spatial sampling rates of the interchange data may be required. For example, using higher spatial sampling rate images allow for specific human as well as machine inspection methods that depend on the analysis of very small details.

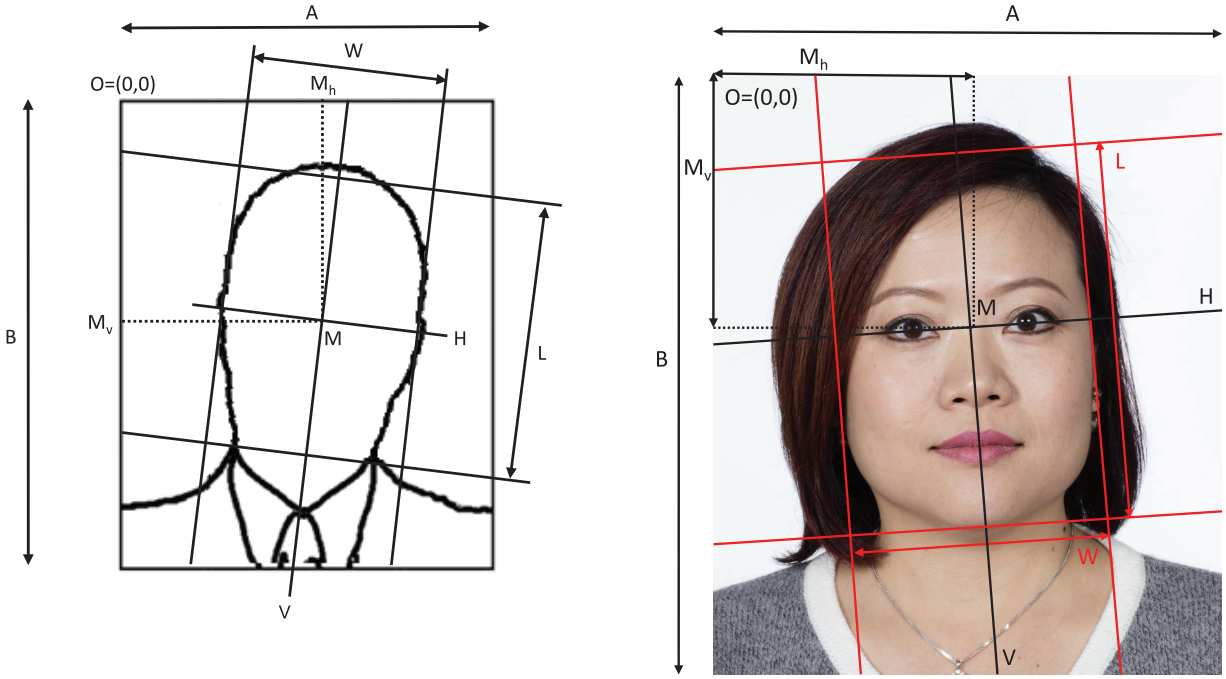
The Image face measurements block consists of four elements. If the number of pixels across the width of the head shall be encoded the Image head width may be used. If the number of pixels across the length of the head shall be encoded the Image head length may be used. If the inter-eye distance shall be encoded the Image inter-eye distance data element may be used. If the eye-to-mouth distance shall be encoded the Image eye-to-mouth distance data element may be used. If necessary, all four elements may be used.

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7.48 Image head width

Abstract values: Integer.

Contents: The Image head width element provides information on the number of pixels in the image across the width of the head. The head width (W) is defined in Figure 9.



a) Abstract geometric characteristics **b) Sample**

Key

A image width
B image height
W head width
L head length
V vertical centre line
H horizontal centre line
M face centre

Figure 9 — Abstract geometric characteristics of a portrait applied to a sample

NOTE The typical inter-eye distance is approximately half of the head width.

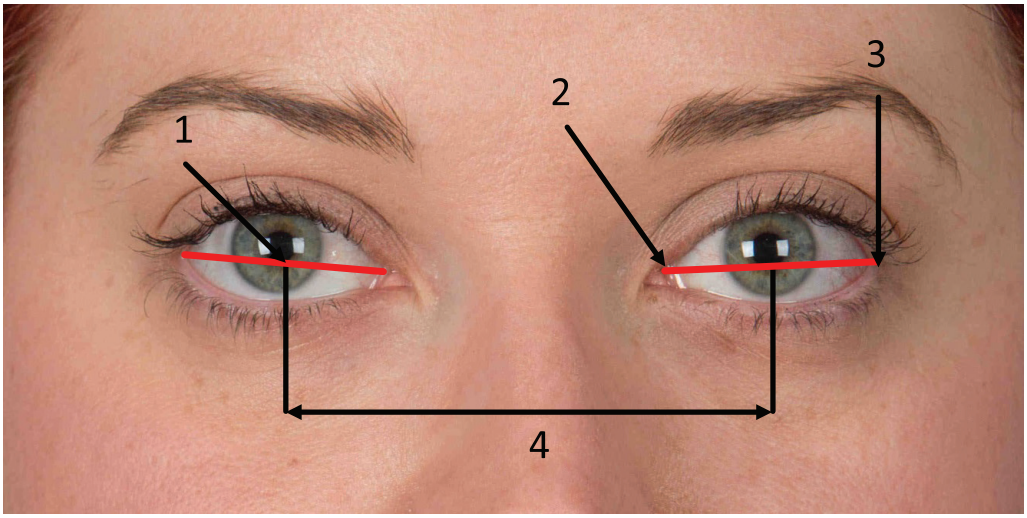
7.49 Image inter-eye distance

Abstract values: Integer.

Contents: The Image inter-eye distance element provides information on the number of pixels in the image between the eye centres (feature points 12.1 and 12.2). For an explanation of the inter-eye distance see Figure 10. The value of this element shall be the number of pixels between the eye centres.

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Key

1 eye centre
2 inner canthus
3 outer canthus
4 Inter-eye distance

Figure 10 — Inter-eye distance (IED) measurement

NOTE Be aware that the eye centre is not necessarily the centre of the pupil.

NOTE A typical real IED (distance measured at the face) is between 60 mm and 65 mm.

7.50 Image eye-to-mouth distance

Abstract values: Integer.

Contents: The Image eye-to-mouth distance element provides information on the number of pixels in the image between the mouth and the eyes. The value of this element shall be the number of pixels between the midpoint of the line connecting the eye centres (feature points 12.1 and 12.2) and the mouth (feature point 2.3).

7.51 Image head length

Abstract values: Integer.

Contents: The Image head length element provides information on the number of pixels in the image from the chin to crown, or length, of the head. The head length (L) is defined in Figure 9. The value of this element shall be the number of pixels across the length of the head.

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7.52 Image colour space

Abstract values: The value of this element shall be one of the following:

— unknown;

— other;

— 24 bit RGB;

— 48 bit RGB;

— YUV422;

— 8 bit greyscale;

— 16 bit greyscale.

Contents: The Image colour space element indicates the colour space used in the encoded 2D or 3D image information block. RGB encoding is recommended. The ICC profile should be embedded inside the Texture map data (if applicable), as JPEG and PNG formats allow ICC profile encoding.

7.53 Reference colour mapping block

Abstract values: None.

Contents: Mapping of reference colours like in IEC 61966-8. This data element contains the name of the applied Reference colour schema, like IEC 61966-8, and a list of Reference colour definition and value blocks.

7.54 Reference colour schema

Abstract values: Octet string.

Contents: This data element contains the name of the applied Reference colour schema, like IEC 61966-8.

7.55 Reference colour definition and value block

Abstract values: Two octet strings.

Contents: These data elements contain pairs of elements consisting of a Reference colour definition like "J 14" in the IEC case, and the respective Reference colour value in the given face portrait.

7.56 3D shape representation block

Abstract values: None.

Contents: The 3D shape representation block contains the 3D representation data, the 3D image information block, and the 3D capture device block. The structure of the 3D shape representation block is shown in Figure 1.

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7.57 3D representation data

Abstract values: Octet string.

Contents: The 3D representation data element shall contain the image data in a vertex representation. The 3D representation kind (vertex) shall be specified in the 3D representation kind element.

7.58 3D capture device block

Abstract values: None.

Contents: In analogy to the 2D capture device block in the 2D image representation block, where the source of the 2D data can be coded, the 3D capture device block should be used to indicate the device that was used to acquire the 3D data.

The 3D capture device block consists of the 3D modus element and the 3D capture device technology identifier 3D element.

If all elements of the 3D capture device block are absent the 3D capture device block element shall be absent.

7.59 3D modus

Abstract values: The value of this element shall be one of the following:

— unknown;

— active;

— passive.

Contents: This element describes the manner in which the 3D image is acquired.

7.60 3D capture device technology identifier

Abstract values: The value of this element shall be one of the following:

— unknown;

— stereoscopic scanner;

— moving (monochromatic) laser line;

— structured light;

— colour coded light;

— ToF (time of flight);

— shape from shading.

Contents: This element contains information on the technology used in the capture device used.

NOTE Some of the listed 3D capture device technology identifier abstract values are incompatible with a 3D modus value of passive.

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7.61 3D image information block

Abstract values: None.

Contents: The 3D image information block consists of the the 3D representation kind block, the 3D coordinate system, the 3D Cartesian scales and offsets block, the Image colour space (see 7.52), the 3D face image kind, the Image size block (see 7.44), the 3D physical face measurements block, the Post acquisition processing block (see 7.38), and the 3D texture map block. The structure of this element is shown in Figure 1.

7.62 3D representation kind block

Abstract values: Vertex.

Contents: The 3D representation kind block shall contain the name of the encoding schema used for the 3D representation data, which is 3D vertex block for this version of this document.

3D vertex block codes 3D points based on a non-regular sampling interval, typically resulting in a sparse coding. Due to variable sampling of the vertex points the vertex representation on the one hand can result in very compact representations or in a very exact representation when using many vertices.

7.63 3D vertex block

Abstract values: None.

Contents: The 3D vertex block consists of at one or more 3D vertex information blocks, and one or more 3D vertex triangle data blocks.

The Coordinate system type for vertex data shall be Cartesian. All Cartesian coordinates shall be non-negative integer. After application of Cartesian scales and offsets, the Cartesian coordinates become metric Cartesian coordinates which can be negative and positive and decimal.

The origin of the metric Cartesian coordinates is defined. For example, this origin is linked to landmarks like the middle of the 2 eyes for the 3D textured image application profile, or like to the top of the nose.

The scale is defined to be in conformity with the 3D textured image resolution block.

7.64 3D vertex information block

Abstract values: None.

Contents: The 3D vertex information block consists of the 3D vertex coordinates block, the 3D vertex identifier, the 3D vertex normals block, the 3D vertex textures block, and the 3D error map elements.

7.65 3D vertex coordinate block

Abstract values: 3D coordinate Cartesian unsigned short block, see ISO/IEC 39794-1.

Contents: The location of each vertex is represented by its X coordinate, Y coordinate, and Z coordinate.

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7.66 3D vertex identifier

Abstract values: Integer.

Contents: This element shall obtain a unique identifier for the associated vertex. Each two vertices in a record shall have different identifiers.

NOTE If the 3D vertex identifier is absent for a vertex, it is impossible to refer to it in the 3D vertex triangle data block.

7.67 3D vertex normals block

Abstract values: 3D coordinate Cartesian unsigned short block, see ISO/IEC 39794-1.

Contents: The 3D vertex normals block contains the normal X, normal Y and normal Z coordinate elements.

7.68 3D vertex textures block

Abstract values: 2D coordinate Cartesian unsigned short block, see ISO/IEC 39794-1.

Contents: The vertex texture X and vertex texture Y fields represent the corresponding x and y pixel position in the 3D texture map block with (0, 0) denoting the upper left corner.

7.69 3D error map

Abstract values: Octet string.

Contents: The 3D error map can be used to give further information on how the 3D data has been processed before it was stored in the 3D representation. The 3D error map shall be coded in the PNG format using an 8 bit per pixel greyscale image. The length of the map is variable, as it depends on the lossless compression algorithm.

Pixel values t in the range of 0 to 199 and 206 to 255 are reserved for future use. A value of t = 200 codes that the depth value is considered to be correct. Values of t ≥ 201 code a specific potential or corrected defect of the 3D data or the corresponding texture image. See Table 6 for an enumerated list of possible values.

Table 6 — 3D error map values

Description	Value
Reserved for future use	0 to 199
Depth value is considered correct	200
Depth value is interpolated, interpolation type isn't specified	201
Depth value is interpolated, linear interpolation has been used	202
Depth value is interpolated, bi-cubic interpolation has been used	203
Value of optional texture image potentially wrong (texture noisy, overexposure, etc.)	204
Value of optional texture image has been corrected by post processing (image processing)	205
Reserved for future use	206 to 255

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7.70 3D vertex triangle data block

Abstract values: None.

Contents: The 3D vertex triangle data block contains a list of triangle descriptions. Each triangle is specified by the three indices (Triangle index 1, Triangle index 2, and Triangle index 3) of the vertices in the vertex data list forming the triangle. The order of the vertex indices shall be counter clock wise to indicate the external face of the triangle.

7.71 3D coordinate system

Abstract values: 3D Cartesian coordinate system.

Contents: This element contains information on the coordinate system used.

Originally, 3D data is acquired in a device dependent coordinate system. Based on the knowledge about several device parameters the 3D data can be transformed in Cartesian coordinates. This transformation may involve rotation, translation and resampling. Efforts must be made to preserve the precision of the original data as intended by this document and defined by the 3D textured image resolution block.

This document supports the Cartesian coordinate system for all encodings.

The transformation to metric world coordinates is described by appropriate scaling factors and implicit rules (e.g. as used in the anthropometric landmark type).

7.72 3D Cartesian coordinate system

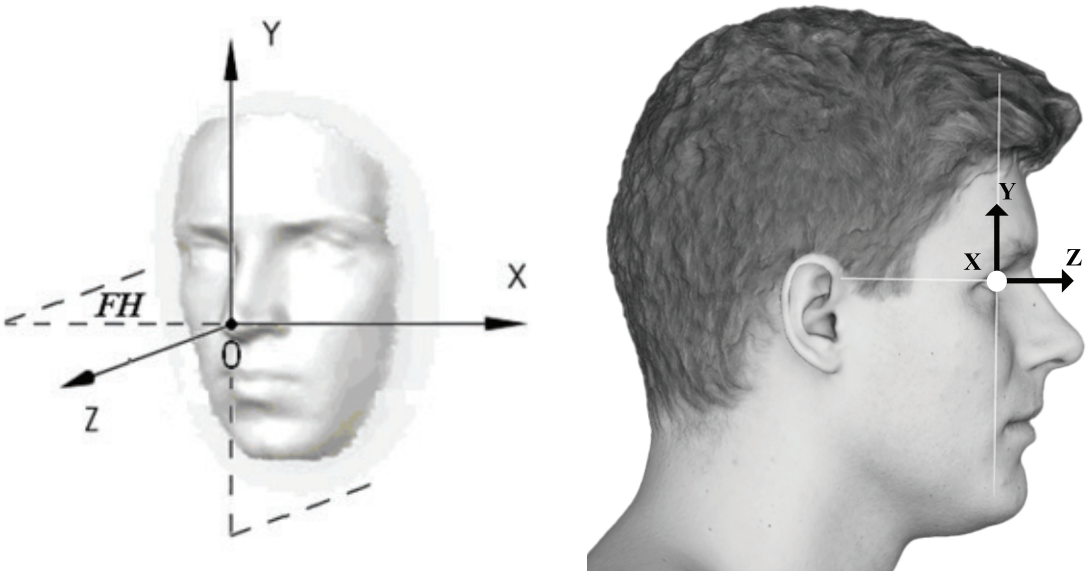
Abstract values: None.

Contents: In the 3D Cartesian coordinate system, the point of origin must be defined in order to get positive encoding of XYZ coordinates.

Figure 11 shows two examples of a metric Cartesian coordinate system. In the left, a sample of a Cartesian coordinate system with the origin on the tip of the nose is shown. The XZ plane is defined parallel to the Frankfurt Horizon. In the right, a sample of a metric Cartesian coordinate system with the origin at the middle of the two eyes is given. The XZ plane passes the horizontal gaze axis. This metric Cartesian coordinate system is used by the 3D textured face image application profile. The X axis leads from right eye to left eye, the Z axis is in Horizontal eye direction, looking straight forward in rest position.

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Key

X, Y, Z	coordinate axes
FH	Frankfurt Horizon
0	coordinate origin

Figure 11 — Samples of Cartesian coordinate systems

7.73 3D Cartesian scales and offsets block

Abstract values: Real.

Contents: ScaleX, ScaleY, ScaleZ, OffsetX, OffsetY and OffsetZ are needed to transform digital coordinates to metric coordinates. The scale values have no dimension, the offset values are given in millimetres.

The transformation from Cartesian coordinates to metric Cartesian coordinates is derived as follows:

— *X = x * ScaleX + OffsetX;*

— *Y = y * ScaleY + OffsetY;*

— *Z = z * ScaleZ + OffsetZ.*

There is a strong relation between anthropometric landmarks and the metric Cartesian coordinate system, as the landmarks define the origin and the orientation.

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