

Information technology — Biometric data interchange formats —

Part 5: Face image data

ICS 35.040

National foreword

This British Standard is the UK implementation of ISO/IEC 19794-5:2005+A2:2009, incorporating corrigenda 1 and 2, July 2008, June 2013 and November 2015. It supersedes BS ISO/IEC 19794-5:2005+A1:2007, which is withdrawn.

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Information technology — Biometric data interchange formats —

Part 5: Face image data

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biométriques —*

Partie 5: Données d'image de la face



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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 19794-5 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

ISO/IEC 19794 consists of the following parts, under the general title *Information technology — Biometric data interchange formats*:

- *Part 1: Framework*
- *Part 2: Finger minutiae data*
- *Part 3: Finger pattern spectral data*
- *Part 4: Finger image data*
- *Part 5: Face image data*
- *Part 6: Iris image data*

The following parts are under preparation:

- *Part 7: Signature/sign behavioral data*
- *Part 8: Finger pattern skeletal data*

Introduction

Face images, also commonly referred to as displayed portraits, have been used for many decades to verify identity of persons. In recent years, digital face images are used in many applications including human examination as well as computer automated face recognition. Although photographic formats have been standardized in some cases such as passport and driver license, it is also demanded to define a standard data format of digital face images to allow interoperability among vendors.

This part of ISO/IEC 19794 is intended to provide a Face Image Format for face recognition applications requiring exchange of face image data. The typical applications are:

- 1) human examination of facial images with sufficient resolution to allow a human examiner to ascertain small features such as moles and scars that might be used to verify identity;
- 2) human verification of identify by comparison of persons against facial images;
- 3) computer automated face identification (one-to-many searching);
- 4) computer automated face verification (one-to-one matching).

To enable many applications on variety of devices, including devices that have the limited resources required for data storage, and to improve face recognition accuracy, this part of ISO/IEC 19794 specifies not only a data format, but also scene constraints (lighting, pose, expression etc), photographic properties (positioning, camera focus etc), digital image attributes (image resolution, image size etc).

Several image types are introduced to define categories that satisfy requirements of some applications. Each requirement is specified for each image type.

The record format specified in this part of ISO/IEC 19794 is designed to be embedded in a CBEFF-compliant structure specified in ISO/IEC 19785. The embedment in the CBEFF structure is described in ISO/IEC 19794-1.

Information technology — Biometric data interchange formats —

Part 5: Face image data

1 Scope

This part of ISO/IEC 19794

- specifies a record format for storing, recording, and transmitting the information from one or more facial images within a CBEFF data structure,
- specifies scene constraints of the facial images,
- specifies photographic properties of the facial images,
- specifies digital image attributes of the facial images.

Each requirement is specified for the following Face Image Types, respectively.

- **Basic:** This is the fundamental Face Image Type that specifies a record format including header and image data. All Face Image Types adhere to the properties of this type. No mandatory scene, photographic and digital requirements are specified for this image type.
- **Frontal:** A Basic Face Image Type that adheres to additional requirements appropriate for frontal face recognition and/or human examination. Two types of Frontal Face Image Types are defined in this document, Full Frontal and Token Frontal (or simply Token).
- **Full Frontal:** A Face Image Type that specifies frontal images with sufficient resolution for human examination as well as reliable computer face recognition. This type of Face Image Type includes the full head with all hair in most cases, as well as neck and shoulders. This image type is suitable for permanent storage of the face information, and it is applicable to portraits for passport, driver license, and “mugshot” images.
- **Token Frontal:** A Face Image Type that specifies frontal images with a specific geometric size and eye positioning based on the width and height of the image. This image type is suitable for minimizing the storage requirements for computer face recognition tasks such as verification while still offering vendor independence and human verification (versus human examination which requires more detail) capabilities.

Table 1 shows the relationships between Face Image Types using the notion of inheritance. For example, Frontal inherits properties from Basic, which means that all normative clauses that apply to Basic also apply to Frontal.

Table 1 – Inheritance of Face Image Types

Face Image Type	Inherits from	Normative clauses	Informative clauses
Basic	None	1, 2, 3, 4, 5, 6	A.1
Frontal	Basic	7	A.2
Full Frontal	Frontal	8	A.3
Token	Frontal	9	A.4

Figure 1 gives a general overview of the scene, photographic, digitization, and format requirements for the face image types specified in this part of ISO/IEC 19794.

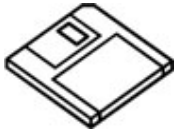
Requirements			
Scene	Photographic	Digital	Format
 Lighting  Image and Subject	 Positioning  Camera Attributes	 Digital Camera  Analogue to Digital  Image Scanning	 Digital Specifications  Record Format and Organization
<i>Clauses:</i> Basic Face None Frontal Face 7.2 Full Frontal Face 8.2	<i>Clauses:</i> Basic Face None Frontal Face 7.3 Full Frontal Face 8.3	<i>Clauses:</i> Basic Face None Frontal Face 7.4 Full Frontal Face 8.4 Token Face 9.2	<i>Clauses:</i> Basic Face 5 6.2 6.3 6.4 Frontal Face 7.5 Full Frontal Face 7.5 Token Face 8.5 9.3

Figure 1 – The types of imaging requirements specified in this part of ISO/IEC 19794.
The Basic Face Image Type has no scene, photographic, or digitized requirements

2 Compliance

Conformity with this part of ISO/IEC 19794 requires compliance with the record format specification defined in clauses 5 and the Basic Face Image Type defined in clause 6.

In addition, this part of ISO/IEC 19794 defines additional Face Image Types. Compliance with the Full Frontal Face Image Type requires compliance with clauses 5, 6, 7, 8. Conformity with the Token Frontal Image Type requires additional compliance with clause 5, 6, 7, 9.

3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 10918 (all parts), *Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines*

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

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

 ISO/IEC 15948:2004, *Information technology — Computer graphics and image processing — Portable Network Graphics (PNG): Functional specification* 

ISO/IEC 19785 (all parts), *Information technology — Common biometric exchange formats framework*

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

C-Cube Microsystems, JPEG File Interchange Format (JFIF), Version 1.02

PIMA 7667:2001, Photography — Electronic Still Picture Imaging — Extended sRGB Color Encoding — e-sRGB

4 Terms and definitions

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

4.1

chin

the central forward portion of the lower jaw

4.2

colour image

continuous tone image that has more than one channel, each of which is coded with one or multiple bits

4.3

colour space

a way of representing colours of pixels in an image. For instance, RGB, YUV and greyscale are typically used in this document.

4.4

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

4.5

continuous tone image

image whose channels have more than one bit per pixel

4.6

crown

top of the head, or (if obscured by hair or headwear), where the top of the head/skull would be if it could be seen

4.7

dots per inch

DPI

measurement of scanner and printer resolution

4.8

facial image

electronic image-based representation of the portrait of a person

4.9

Face Image Type

a category of facial images that satisfy specific requirements

4.10

FAP

Facial Animation Parameter

4.11

fish eye

a type of distortion where central objects of the image erroneously appear closer than those at the edge

4.12

greyscale image

continuous tone image that has only one luminance channel coded e.g. with 8 bit; also referred to as a monochrome or black and white image

4.13

human examination

process of careful human comparison of a face image with a person or another face image to ascertain the identity of the respective person by a detailed examination of facial features and structures

4.14

human verification

process of human comparison of a face image with a person or another face image to ascertain the identity of the respective person in a short time period; one-to-one (1:1) matching

4.15

identification

process of searching through a list of face images to match against an input image(s); one-to-many (1:N) searching

A₂ 4.16

2D image

two-dimensional representation that encodes the luminance and/or colour texture of a capture subject in a given lighting environment **A₂**

4.17

JPEG

image compression standard specified as ISO/IEC 10918

NOTE The JPEG baseline standard was published as ISO/IEC 10918-1:1994 and ITU-T Rec. T.81.

4.18

JPEG2000

image compression standard specified as ISO/IEC 15444

NOTE The JPEG2000 baseline standard was published as ISO/IEC 15444-1:2000 and ITU-T Rec. T.800.

4.19

Feature Point

reference point(s) in a face image as used by face recognition algorithms, commonly referred to as a landmark

EXAMPLE Position of the eyes.

4.20

pixel

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

4.21

portrait

photograph of a person which includes the full head, with all hair in most cases, as well as neck and top of shoulders

4.22

red-eye

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

4.23

verification

process of ascertaining that two images or image inputs represent the same person; one-to-one (1:1) matching

A₂ 4.24

3D image

representation that encodes a surface in a 3D space

4.25

3D point map

3D point cloud representing a capture subject, where each surface point is encoded with a triplet, representing the x, y and z values of the point in 3D

4.26

3D vertex representation

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

4.27

anthropometric landmark

landmark point on the face used for identification and classification of humans

4.28

anthropometric landmark code

two-part code that defines an anthropometric landmark uniquely **A₂**



4.29

Cartesian coordinate system

3D orthogonal coordinate system

4.30

cylindrical coordinate system

three-dimensional polar coordinate system describing a point by the three components radius, azimuth and height

4.31

range image

numerical matrix that encodes a surface point in 3D space, where the position encodes the first two coordinates and the value at that position encodes the third coordinate

4.32

PNG format

lossless image compression standard specified in ISO/IEC 15948

4.33

texture

two-dimensional representation of the luminance and/or colour of a capture subject in a given lighting environment

4.34

texture projection matrix

3x4 matrix to transform a 3D surface coordinate from a metric Cartesian Coordinate System to a 2D texture image coordinate, where the transformation makes use of the 3D homogenous coordinates of the 3D point as well as the 2D homogenous coordinates of the 2D point

NOTE See bibliography item [13] for details.

5 The face record format



5.1 Overview

The face record format specified in this document is a format to store face image data within a biometric data record. Each record shall pertain to a single subject and shall contain at least one or more 2D image and zero or more geometric representations (range images, 3D point maps, 3D vertex representations) of a human face. Depending on the face image type, a 3D representation of a face may be included in addition to the 2D image. This record is embedded in the biometric data block in a CBEFF compliant structure. The record structure is depicted in Figure 2 and Figure 3.

Adherence to this format requires compliance to the standards referred to above. In particular, the header and the entire data structure will be CBEFF compatible, 2D image data will be encoded using either JPEG or JPEG2000.

A₂

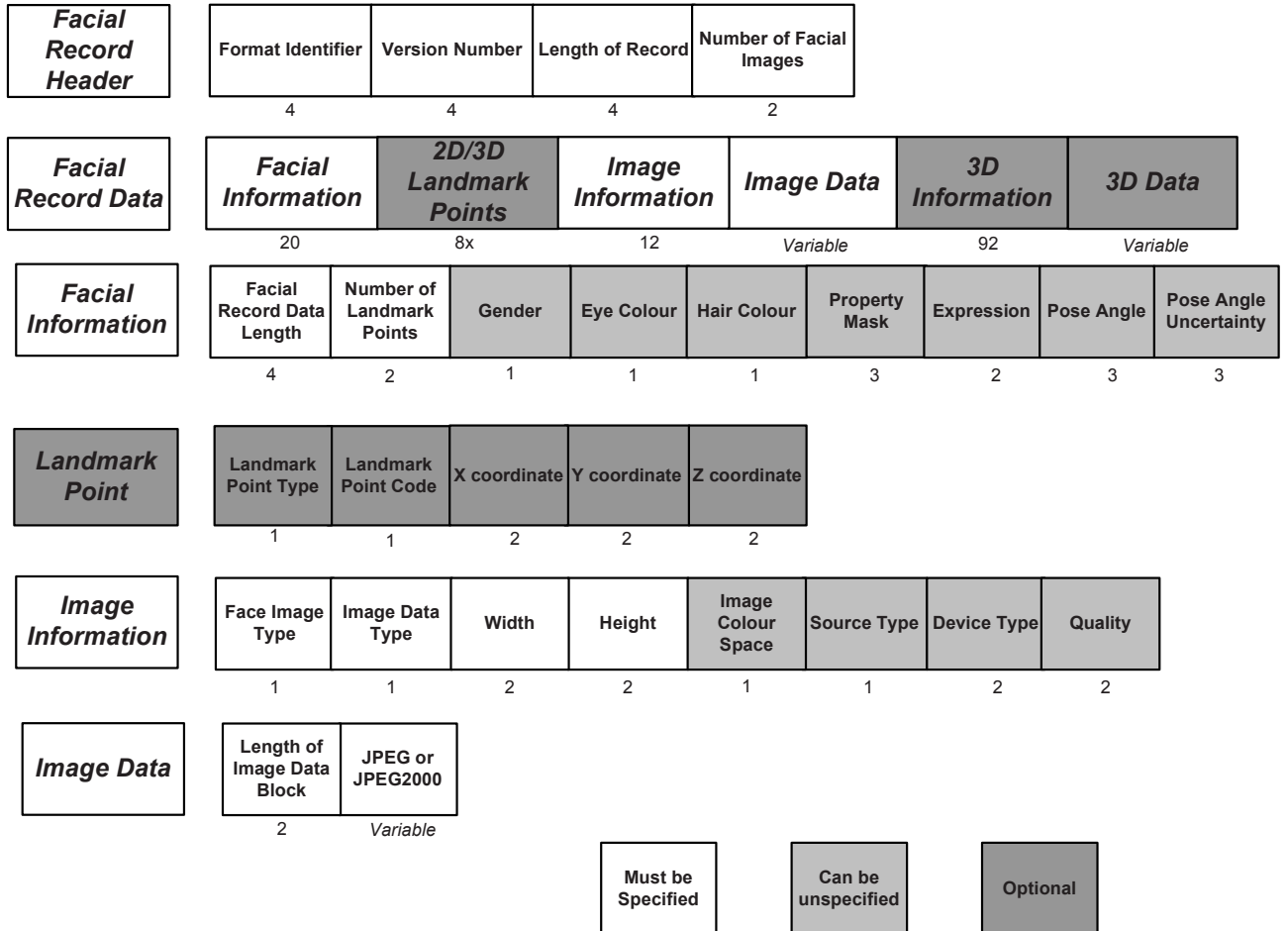


Figure 2 — The Face Image Record format. The length value of each field in bytes is shown below the field. The white boxes indicate fields or blocks that shall be specified, light grey boxes that the fields are mandatory, but an unspecified value is acceptable, and dark grey boxes indicate optional fields. Note, that the 3D Information block and 3D Data block are mandatory for the 3D Types. A₂

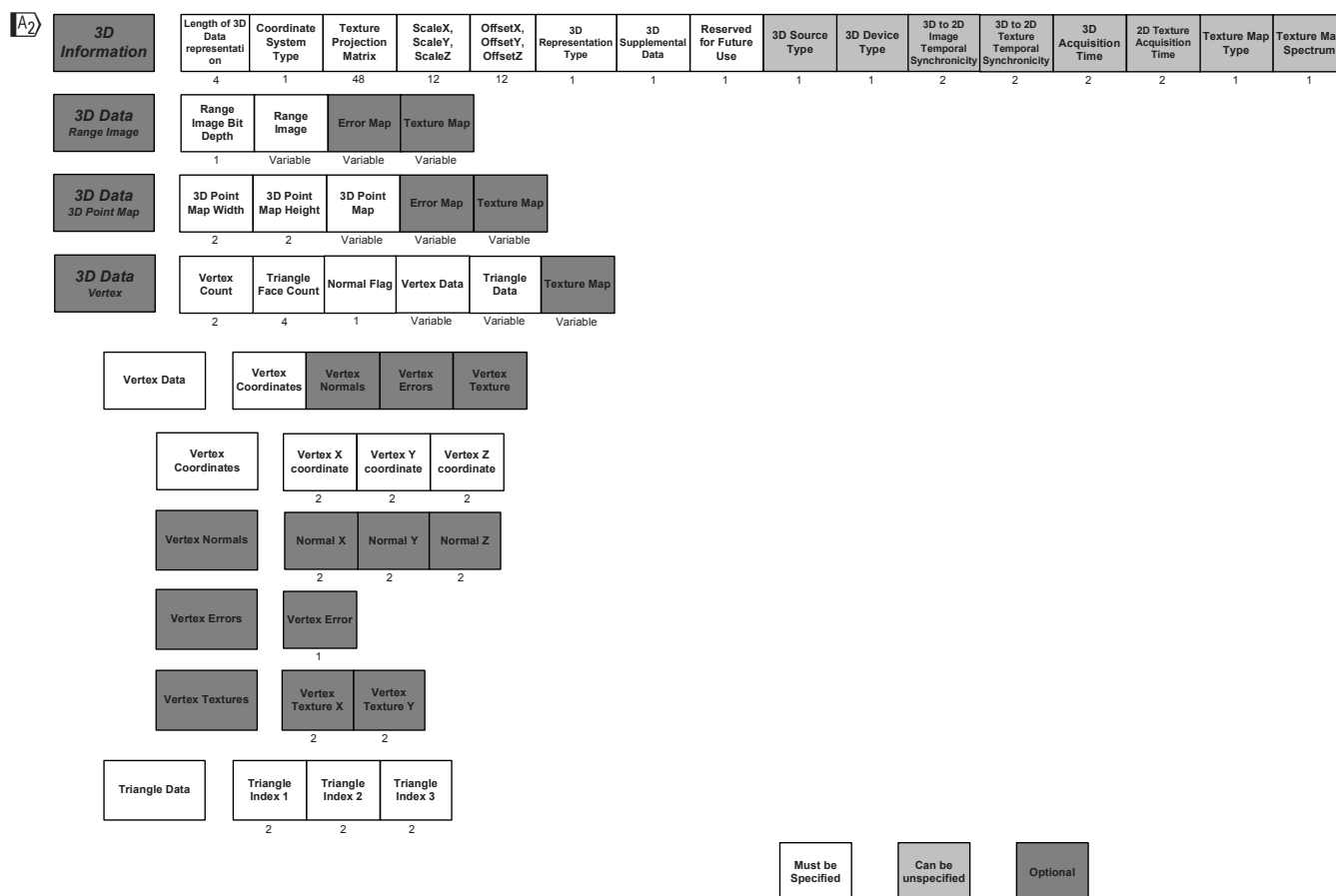


Figure 3 — The 3D Information block and the three possible 3D Data blocks specified in this standard. The length value of each field in bytes is shown below the field. The white boxes indicate fields or blocks that shall be specified, light grey boxes that the fields are mandatory, but an unspecified value is acceptable, and dark grey boxes indicate optional fields.

When referring to elements of the record format, 'field' denotes the elementary unit of information such as Face Image Type and Image Data Type, "block" denotes the group of fields such as Facial Information block or Image Information block, and "record" denotes the biometric reference which consists of the Facial Record Header and one or more Facial Record Data.

With the exception of the Format Identifier and the Version Number for the standard, which are null-terminated ASCII character strings, all data is represented in binary format.

There are no record separators or field tags; fields are parsed by byte count.

The organization of the record format is as follows:

- A fixed-length (14 byte) **Facial Record Header** containing information about the overall record, including the number of facial images represented and the overall record length in bytes.
- A **Facial Record Data** block for each facial image. This data consists of
 - A fixed length (20 byte) **Facial Information** block describing discernable characteristics of the subject such as gender.
 - Multiple (including none) fixed length (8 byte) **Landmark Point** blocks describing 2D or 3D Landmark Points on a face.
 - A fixed length (12 byte) **Image Information** block describing digital properties of the image such as Face Image Type and dimensions such as width and height. ^{A2}

- **Image Data** consisting of a JPEG or JPEG2000 encoded data block.
- For Face Image Types containing 3D information a **3D Information** block (92 byte) describing properties of this data.
- For Face Image Types containing 3D information the **3D Data** block describing the 3D shape of the face.

Multiple images / 3D-representations of the same biometric data subject can be described in a single CBEFF record. This is accomplished by including multiple Facial Record Data blocks after the Facial Record Header block and before the CBEFF Signature block. Facial Record Data blocks containing 2D data can be stored together with Facial Record Data blocks also containing 3D data. The structure of this embedding is illustrated in Figure Amd.2-1.

CBEFF Header	Facial Record Header	Facial Record Data 1 (Full Frontal)	Facial Record Data 2 (Token Frontal)	Facial Record Data 3 (Full Frontal Range)	CBEFF Signature
--------------	----------------------	--	---	--	-----------------

Figure Amd.2-1 – Embedding multiple images / 3D representations in the same record. ^(A2)

5.2 Data Conventions

5.2.1 Byte ordering

Within the record format and all well-defined data blocks therein, all multi-byte quantities are stored in Big-Endian format. That is, the more significant bytes of any multi-byte quantity are stored at lower addresses in memory than less significant bytes. For example, the value 1025 (2 to the 10th power plus one) would be stored as first byte= 00000100 and second byte=00000001.

5.2.2 Numeric values

All numeric values are fixed-length unsigned integer quantities, unless otherwise specified.

5.2.3 Conversion to integer

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.

5.2.4 Unspecified field value

The field value of zero (0x00) shall be used to denote that the creator of the record did not make the determination of the information encoded in the field. The only exception is the value of zero assigned to JPEG in the Image Data Type field in clause 5.7.2.

5.2.5 Unknown field value

A field value labelled by the identifier “Unknown” shall be used to denote that the information encoded by the field cannot be determined by examination of the face image.

5.3 The CBEFF Header

The biometric data record represented using the face record format shall be embedded in the biometric data block(BDB) of the CBEFF patron format compliant with ISO/IEC 19785-1:2004.

The CBEFF patron format requests to specify both CBEFF_BDB_format_owner and CBEFF_BDB_format_type as mandatory elements in the CBEFF Header.

The CBEFF_BDB_format_owner shall be specified by the CBEFF biometric organization identifier issued by the CBEFF registration authority to ISO/IEC JTC1/SC37. This value is the sixteen bit value 0x0101.

The CBEFF_BDB_format_type shall be specified by the CBEFF BDB format type identifier assigned by ISO/IEC JTC1/SC37 to this face record format. This value is the sixteen bit value 0x0008.

Complete CBEFF header information required for coding is given in Part 1 (Framework) of this standard.

5.4 The Facial Record Header

The Facial Record Header block consists of four fields; Format Identifier, Version Number, Length of Record, Number of Facial Images as shown in Table 2.

AC₃ Table 2 – The Facial Record Header

Field	Size	Valid values	Notes
Format Identifier	4 bytes	0x46414300 ('F' 'A' 'C' 0x0)	Indicates face image data
Version Number	4 bytes	0x30313000 ('0' '1' '0' 0x0)	"010" in ASCII
Length of Record	4 bytes	$57 \leq \text{Length of Record} \leq 2^{32} - 1$	Includes Facial Record Header and Facial Record Data. The minimum length of 57 includes the smallest JPEG image
Number of Facial Images	2 bytes	$1 \leq \text{Number} \leq 65535$	AC ₃

5.4.1 Format Identifier

The (4 byte) Format Identifier shall consist of three ASCII characters "FAC" followed by a zero byte as a NULL string terminator to identify the record format as the face record format.

A₂ 5.4.2 Version Number

The (4 byte) Version Number field shall consist of three ASCII numerals followed by a zero byte as a NULL string terminator.

The first and second characters represent the major version number and the third character represents the minor revision number.

The Version Number of ISO/IEC 19794-5 AC₃:2005 AC₃ shall be 0x30323000; "020" – Version 2 revision 0. A₂

5.4.3 Length of Record

The (4 byte) Length of Record field shall be the combined length in bytes for the record. This is the entire length of the record including the Facial Record Header and Facial Record Data.

5.4.4 Number of Facial Images

The (2 byte) Number of Facial Images field shall be the number of facial images included in the record.

5.5 The Facial Information block

The (20 byte) Facial Information block is intended to describe discrete properties of the individual discernable from the image, one is included for each facial image included in the record. The structure of this block is shown in Figure 2.

Zero or more Feature Point blocks, one Image Information block, and one Image Data block follow this block.

5.5.1 Facial Record Data Length

The (4 byte) Facial Record Data Length field denotes the sum of the lengths of the Facial Information block, the Feature Point block(s), the Image Information block, and the Image Data block.

The minimum value of the Facial Record Data Length is 32 bytes plus the size of the Image Data block (in bytes).

5.5.2 Number of Feature Points

The (2 byte) Number of Feature Points field shall be the number of Feature Point blocks that follow the Facial Information block. The Feature Point block is defined in clause 5.6.

5.5.3 Gender

The (1 byte) Gender field shall represent the gender of the subject according to Table 3.

Table 3 – Gender codes

Description	Value
Unspecified	0x00
Male	0x01
Female	0x02
Unknown	0xFF

5.5.4 Eye Colour

The (1 byte) Eye Colour field shall represent the colour of irises of the eyes according to Table 4. If the eyes are different colours, then right eye colour is to be encoded.

Table 4 – Eye Colour codes

Description	Value
Unspecified	0x00
Black	0x01
Blue	0x02
Brown	0x03
Gray	0x04
Green	0x05
Multi-Coloured	0x06
Pink	0x07
Reserved	0x08 – 0xFE
Other or Unknown (e.g. can not be determined from image, monochrome image)	0xFF

5.5.5 Hair Colour

The (1 byte) Hair Colour field shall represent the colour of the hair according to the Table 5.

Table 5 – Hair Colour codes

Description	Value
Unspecified	0x00
Bald	0x01
Black	0x02
Blonde	0x03
Brown	0x04
Gray	0x05
White	0x06
Red	0x07
Reserved	0x08 – 0xFE
Unknown or Other	0xFF

5.5.6 Property Mask

The (3 byte) Property Mask is a bit mask of 3 bytes and each bit of the mask position listed in Table 6 shall be set to 1 if the corresponding property is present, and set to 0 if absent. The mask position starts from 0 at the lowest bit. The lowest bit set to 0 shall indicate that properties are not specified ^{AC3} (and all bits shall be zero) ^{AC3}; the lowest bit set to 1 shall indicate that all listed properties have been considered and that a zero value of any property bit indicates an absence of that property.

^{AC3} All reserved bits shall be zero. ^{AC3}

Table 6 – Property flags

Description	Mask Position
Properties are specified	0
Glasses	1
Moustache	2
Beard	3
Teeth visible	4
Blink (either or both eyes closed)	5
Mouth open	6
Left Eye Patch	7
Right Eye Patch	8
Dark Glasses (medical)	9
Feature Distorting Medical Condition (which could impact Feature Point detection)	10
Reserved ^{AC3} Text deleted ^{AC3}	11 – 23

^{AC3} A Blink flag set to “1” shall indicate non-compliance with the Frontal, Full Frontal, and Token image types. ^{AC3}

5.5.7 Expression

The (2 byte) Expression field shall represent the expression of the face according to Table 7.

Table 7 – Expression Codes

Description	High Byte	Low Byte
Unspecified	0x00	0x00
Neutral (non-smiling) with both eyes open and mouth closed)	0x00	0x01
A smile where the inside of the mouth and/or teeth is not exposed (closed jaw).	0x00	0x02
A smile where the inside of the mouth and/or teeth is exposed.	0x00	0x03
Raised eyebrows	0x00	0x04
Eyes looking away from the camera	0x00	0x05
Squinting	0x00	0x06
Frowning	0x00	0x07
Reserved AC₃ Text deleted AC₃	0x00	0x08 – 0xFF
	0x01 – 0x7F	0x00 – 0xFF
AC₃ Vendor Specific AC₃	0x80 – 0xFF	0x00 – 0xFF

5.5.8 Pose Angle

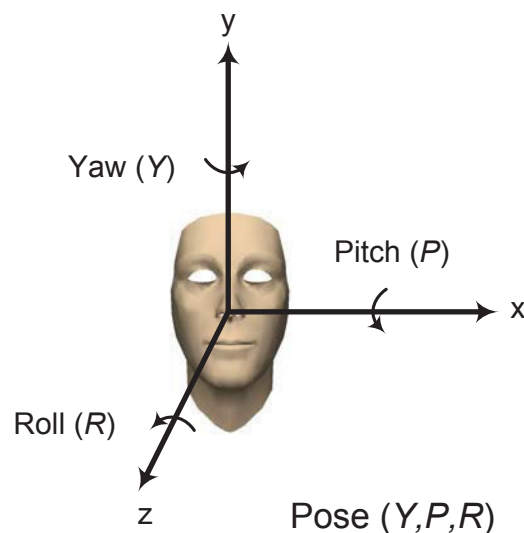


Figure 4 – The definition of pose angles is with respect to the frontal view of the subject

The (3 multi-byte) Pose Angle field (B_Y , B_P , B_R) shall represent the estimate or measure pose of the subject in the image. Each byte in the field respectively represents pose angles of yaw, pitch and roll in that order. The pose angle is given by Tait-Bryan angles.

- Yaw angle: rotation about the vertical (y) axis.
- Pitch angle: rotation about the horizontal side-to-side (x) horizontal axis.
- Roll angle: rotation about the horizontal back to front (z) axis.

The angles are defined relative to the frontal view of the subject, which has angles (0,0,0) as shown in Figure 4. The examples are shown in Figure 5.

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 (x,y) plane.

From the point of view of executing a transformation from the observed view to a frontal view, the transformation order will therefore be Yaw, Pitch, and then Roll. Note however that the encoded angle is from the frontal view to the observed view.

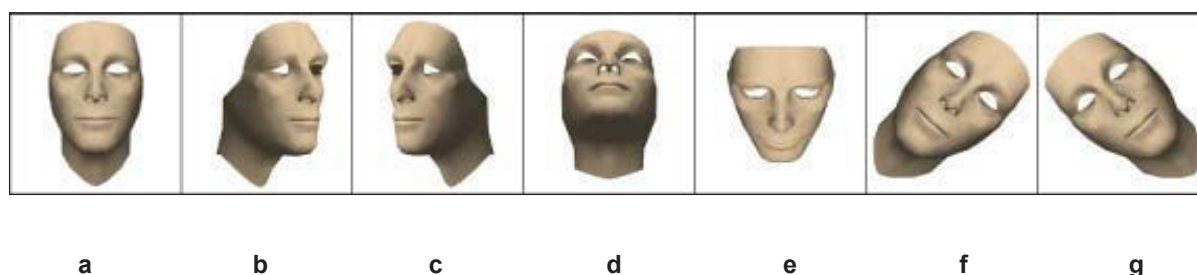


Figure 5 – Examples of pose angles and their encodings. The pose angles (Y, P, R) of figures a – g are given by (0, 0, 0), (+45, 0, 0), (-45, 0, 0), (0, -45, 0), (0, +45, 0), (0, 0, -45), and (0, 0, +45), respectively. The pose angle encodings, (B_Y , B_P , B_R) as defined in sections 5.5.8.1 – 5.5.8.3 are subsequently given by (1, 1, 1), (23, 1, 1), (158, 1, 1), (1, 158, 1), (1, 23, 1), (1, 1, 158), and (1, 1, 23), respectively

5.5.8.1 Pose Angle – Yaw

The yaw angle Y is the rotation in degrees about the y-axis (vertical axis) shown in Figure 4. Frontal faces have a yaw angle of 0 degrees. Positive angles represent faces looking to their left (a counter-clockwise rotation around the y-axis).

[AC3] The encoded value, B_Y , shall be stored in 1 byte with values 0 to 180 computed from a real-valued yaw angle estimate, $-180 \leq Y < 180$, as follows: **[AC3]**

- If $180 \geq Y \geq 0$ then $B_Y = Y/2 + 1$. The remainder is discarded.
- If $-180 \leq Y < 0$ then $B_Y = 181 + Y/2$. The remainder is discarded.

The maximum value of B_Y is **[AC3]** 180 **[AC3]**. If the pose angle is not specified, the value of B_Y shall be 0.

5.5.8.2 Pose Angle – Pitch

The pitch angle P is the rotation in degrees about the x-axis (horizontal axis) shown in Figure 4. Frontal faces have a pitch angle of 0 degrees. Positive angles represent faces looking down (a counter-clockwise rotation around the x-axis).

AC3 The encoded value, B_P , shall be stored in 1 byte with values 0 to 180 computed from a real-valued pitch angle estimate, $-180 \leq P < 180$, as follows: **AC3**

- If $180 \geq P \geq 0$ then $B_P = P/2 + 1$. The remainder is discarded.
- If $-180 \leq P < 0$ then $B_P = 181 + P/2$. The remainder is discarded.

The maximum value of B_P is **AC3** 180 **AC3**. If the pitch angle is not specified, the value of B_P shall be 0.

5.5.8.3 Pose Angle – Roll

The roll angle R is the rotation in degrees about the z-axis (the horizontal axis from front to back) shown in Figure 4. Frontal faces have a roll angle of 0 degrees. Positive angles represent faces tilted toward their right shoulder (counter-clockwise rotation around the z-axis).

AC3 The encoded value, B_R , shall be stored in 1 byte with values 0 to 180 computed from a real-valued roll angle estimate, $-180 \leq R < 180$, as follows: **AC3**

- If $180 \geq R \geq 0$ then $B_R = R/2 + 1$. The remainder is discarded.
- If $-180 \leq R < 0$ then $B_R = 181 + R/2$. The remainder is discarded.

The maximum value of B_R is **AC3** 180 **AC3**. If the roll angle is not specified, the value of B_R shall be 0.

5.5.9 Pose Angle Uncertainty

The (3 multi-byte) Pose Angle Uncertainty (U_Y , U_P , U_R) represents the expected degree of uncertainty of the pose angle yaw, pitch, and roll. Each byte in the field respectively represents the uncertainty of yaw, pitch and roll in that order. The uncertainty is allowed to represent experimental uncertainty specified by each vendor.

The encoding of Pose Angle Uncertainty is given by three bytes (U_Y , U_P , U_R) where each byte U_k in the field ($k=Y,P,R$) represents 1 degree of uncertainty with minimum and maximum values of 1 and 181 where $U_k = (\text{uncertainty} + 1)$. The more uncertain, the value of the uncertainty U_k shall become larger. If the uncertainty is not specified, then the values of U_Y , U_P and U_R shall be set to zero (0).

A2 5.6 The Landmark Point block

The optional (8 byte) Landmark Point block specifies the type, code and position of a Landmark Point in the facial image. The number of Landmark Point blocks shall be specified in the Number of Landmark Points field of the Facial Information block. The structure of this block is shown in Table 8.

Landmark Points can be specified as MPEG-4 Feature Points as given by Annex C of ISO/IEC 14496-2:2004 or Anthropometric Landmarks in two or three dimensions. The description of the Anthropometric Landmarks and their relation with the set of MPEG4 Feature Points is discussed in clause 5.6.5. **A2**

^{A2} The horizontal and vertical position of Landmark Points are either texture image coordinates or in the Cartesian Coordinate system (see clause 5.9.2.1).

Table 8 – The Landmark Point block

Field	Size	Value	Notes
Landmark Point Type	1 byte	See clause 5.6.1	Denotes the type of the Landmark Point.
Landmark Point Code	1 byte	See clause 5.6.2	Denotes the Landmark Point, e.g. the left eye.
X coordinate, Y coordinate	2 bytes	See clause 5.6.1, Table Amd.2-1	Denotes the coordinate of the landmark point. For Landmark Point Types 0x01 and 0x02 this coordinate denotes the relevant pixel count from upper left pixel starting at 0. For Landmark Point Type 0x03 the value codes the coordinate of a point in 3D.
Z coordinate	2 bytes	See clause 5.6.1, Table Amd.2-1	Denotes the Z-coordinate of the landmark point. For Landmark Point Type 0x01 and Type 0x02 this field is ignored. For Landmark Point Type 0x03 the value codes the Z coordinate of a point in 3D.

5.6.1 Landmark Point Type

The (1 byte) Landmark Point Type field represents the type of the Landmark Point stored in the Landmark Point block. This field shall be set to 0x01 to denote that landmark point is an MPEG4 Feature Point as given by Annex C of ISO/IEC 14496-2:2004 and is represented by the 2D image coordinates. The field shall be set to 0x02 to denote that the landmark point is an Anthropometric 2D landmark and is represented by the 2D image coordinates. Finally, the field shall be set to 0x03 to denote that the landmark point is an Anthropometric 3D landmark and is represented by its 3D coordinates. All other field values are reserved for future definition of Landmark Point types. ^{A2}

Table Amd.2-1 — The Landmark Point Type

Description	Value	Comment
MPEG4 Feature	0x01	The Horizontal and Vertical position of the landmark point are measured in pixels with values from 0 to Width-1 and Height-1, respectively. The Z coordinate field is ignored.
Anthropometric 2D landmark	0x02	The landmark point is considered as a anthropometric landmark point in the 2-D image and its coordinates are measured in pixels with values from 0 to Width-1 and Height-1, respectively. The Z coordinate field is ignored.
Anthropometric 3D landmark	0x03	<p>X coordinate, Y coordinate and Z coordinate are interpreted as 2 byte values with fixed precision of 0.02 mm ranging from -655.34 mm to 655.34 mm. The landmark point is considered as a 3D point in the Cartesian Coordinate System.</p> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <p><i>Example:</i> The value of 10001 corresponds to</p> $-655.34\text{mm} + 10001 \times 0.02\text{mm} = -455.32\text{mm}.$ </div>
Reserved	0x04-0xFF	Reserved for future use.

5.6.2 Landmark Point Code

The (1 byte) Landmark Point Code field shall specify the Landmark Point that is stored in the Landmark Point block.

For the Landmark Point Type 0x01 the codes of the Landmark Points in clause 5.6.3, taken from Annex C of ISO/IEC 14496-2:2004 and defined as MPEG4 Feature Points, or the additional eye and nostril Landmark Points in clause 5.6.4 shall be stored in this block.

If the Landmark Point Type is 0x02 or 0x03, i.e. Anthropometric 2D landmark or Anthropometric 3D landmark, the codes of the Landmark Points defined in 5.6.5 shall be stored in this block.

5.6.3 MPEG4 Feature Points

The normative Figure 6 denotes the Landmark Point codes associated with Feature Points as given by Annex C of ISO/IEC 14496-2:2004. Each Landmark Point code is represented by a notation A.B using a major (A) and a minor (B) value. The encoding of the Landmark Point code is given by the (1 byte) value of $A \times 16 + B$. ^{A2}

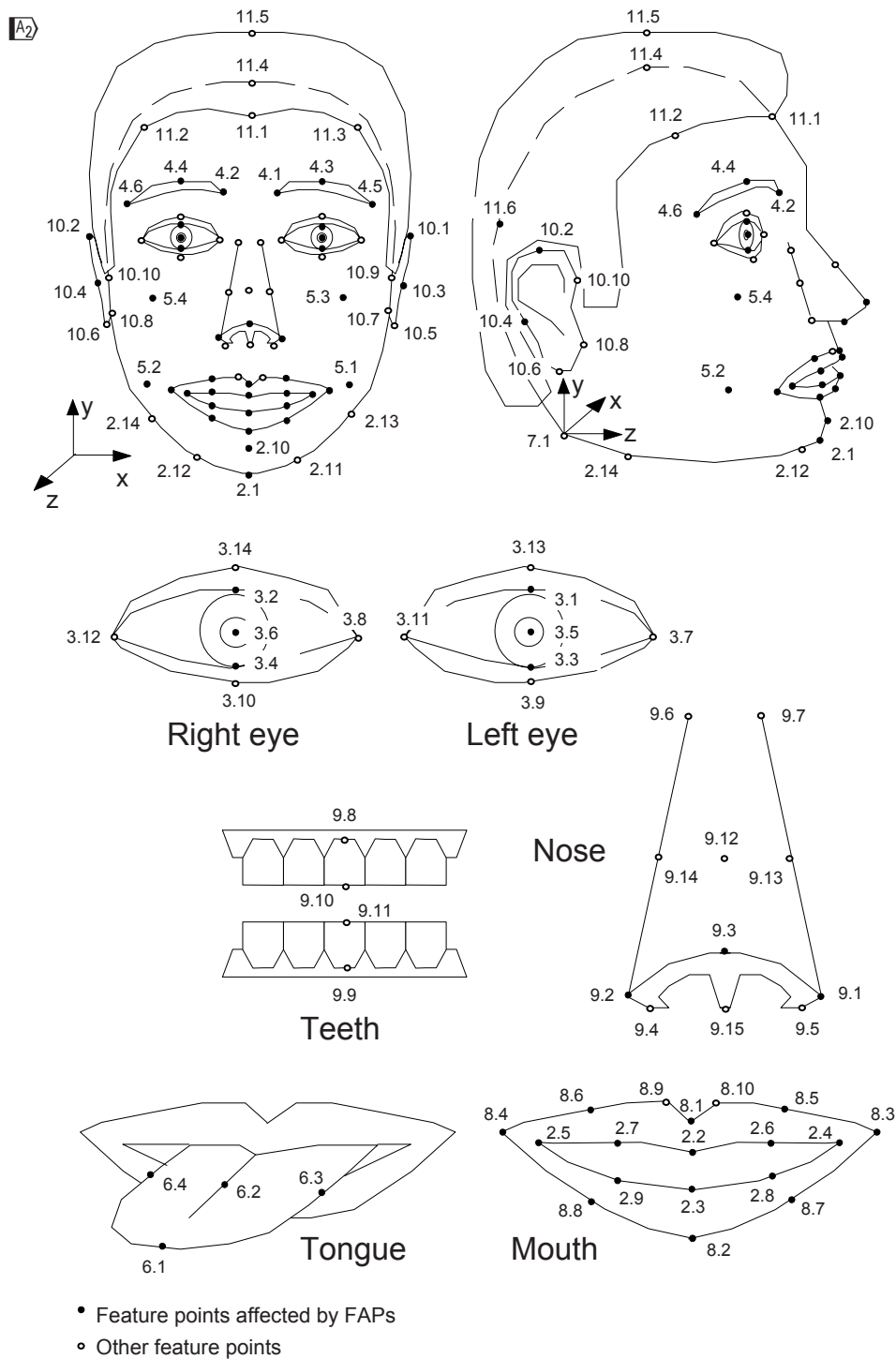


Figure 6 – The MPEG4 Feature Point codes defined in ISO/IEC 14496-2.

Each Landmark Point code in Figure 7 is given by major value A and minor value B. For example, the code for the left corner of the left eye is given by major value 3 and minor value 7. **A₂**

5.6.4 Eye and nostril Landmark Points

The eye centre Landmark Points 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 Point 12.3 is defined to be the midpoint of the nose Landmark Points (9.1, 9.15) in the horizontal direction and (9.3,9.15) in the vertical direction. Similarly, the right nostril centre Landmark Point 12.4 is defined to be the midpoint of the nose Landmark Points (9.2, 9.15) in the horizontal direction and (9.3,9.15) in the vertical direction. Both the eye centre and nostril centre Landmark Points are shown in Figure 7 and values given in Table 9.

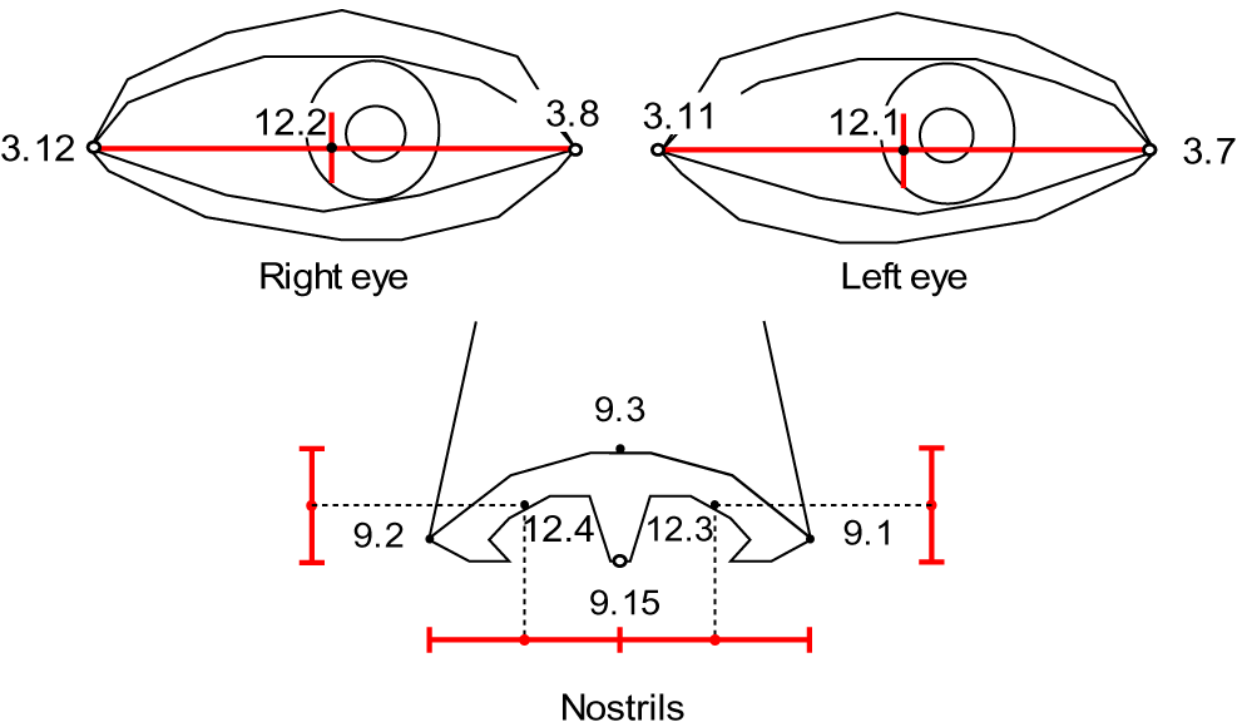


Figure 7 – The eye and nostril centre Landmark Points are defined by midpoints of MPEG4 Feature Points.

Table 9 – Eye and nostril centre Landmark Point codes

Centre Landmark Point	Midpoint of Landmark Points		Landmark Point 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	

A2 5.6.5 Anthropometric Landmarks

Anthropometric Landmarks extend the MPEG4 feature model with new points that are used in forensics and anthropology for person identification via two facial images or image and skull over a long time. They also allow specification of points that are in use by criminal experts and anthropologists.

Figure Amd.2-2 and Table Amd.2-2 show the definition of the Anthropometric Landmarks. The set of points represents the craniofacial landmark points 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.

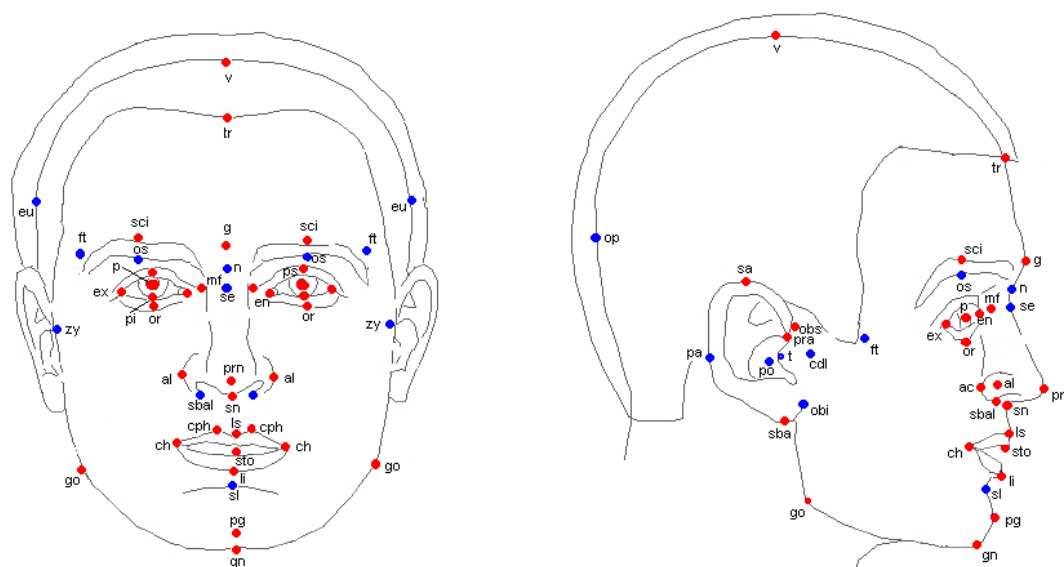


Figure Amd.2-2: Anthropometric Landmarks with (red) and without (blue) MPEG4 counterparts.

Definitions for these points are presented in the Table Amd.2-2.

Table Amd.2-2 – Definitions of the Anthropometric Landmarks

Point ID	Point Code	MPEG4	Anthropometric point name	How to point
v	1.1	11.4	vertex	The highest point of head when the head is oriented in Frankfurt Horizon. Refer to Annex C for the definition of the Frankfurt Horizon.
g	1.2		glabella	The most prominent middle point between the eyebrows

A2

A2

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 forehead, laterally from the elevation of the linea temporalis
tr	1.9	11.1	trichion	The point on the hairline in the midline of the forehead
zy	2.1 2.2		zygion	The most lateral point of each of the zygomatic
go	2.3 2.4	2.15 2.16	gonion	The most lateral point on the mandibular angle close to the bony gonion
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	center 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

A2



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	5.7	9.15	subnasale	The midpoint of the angle at the columella base where the lower border of the nasal septum and the surface of the upper lip meet
sbal	5.9 5.10		subalare	The point at the lower limit of each alar base, where the alar base disappears into the skin of the upper lip
ac	5.11 5.12	9.1 9.2	alar curvature (or alar crest) point	The most lateral point in the curved base line of each ala
mf	5.13 5.14	9.6 9.7	maxillofrontale	The base of the nasal root medially from each endocanthion
cph	6.1 6.2	8.9 8.10	christa philtri landmark	The point on each elevated margin of the philtrum just above the vermillion line
ls	6.3	8.1	labiale (or labrale) superius	The midpoint of the upper vermillion line
li	6.4	8.2	labiale (or labrale) inferius	The midpoint of the lower vermillion line
ch	6.5 6.6	8.3 8.4	cheilion	The point located at each labial commissure



A₂

sto	6.7		stomion	The imaginary point at the crossing of the vertical facial midline and the horizontal labial fissure between gently closed lips, with teeth shut in the natural position
sa	7.1 7.2	10.1 10.2	superaurale	The highest point of the free margin of the auricle
sba	7.3 7.4	10.5 10.6	subaurale	The lowest point of the free margin of the ear lobe
pra	7.5 7.6	10.9 10.10	preaurale	The most anterior point on the ear, located just in front of the helix attachment to the head
pa	7.7 7.8		postaurale	The most posterior point on the free margin of the ear
obs	7.9 7.10	10.3 10.4	otobasion superius	The point of attachment of the helix in the temporal region
obi	7.11 7.12		otobasion infrius	The point of attachment of the ear lobe to the cheek
po	7.13 7.14		porion (soft)	The highest point of the upper margin of the cutaneous auditory meatus
t	8.1 8.2		tragion	The notch on the upper margin of the tragus

The Anthropometric Landmark Code has the format: 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 point has two symmetrical entities (left and right) the right entity always has a greater and even minor code value. Hence, all landmark points from the left part of the face have odd minor codes, and from the right part – even minor codes. Both A and B are in the range from 1 to 15. Hence, the code $A \times 16 + B$ is written to the 1 byte Landmark Point Code field.

5.6.6 Anthropometric 3D landmark

The error of an Anthropometric 3D landmark point location should be no greater than 3 mm. The point shall withstand from the nearest point on the surface no further than 3 mm. The point on the surface is a vertex, or a point on an edge, or a point on a face of the surface.

5.6.7 Z coordinate

This field is not used if the Landmark Point Type is equal to MPEG4 Feature or Anthropometric 2D landmark. In case the Landmark Point Type equals Anthropometric 3D landmark this field along with the horizontal and A₂

^{A2} vertical positions denotes the coordinates of the landmark point in the 3D Cartesian Coordinate System. The metric coordinates of 3D landmarks shall be obtained by multiplying the X, Y, and Z coordinates by a fixed scale of 0.02 mm. Note, that the Landmark Point Type field codes the type of the landmark point and determines the interpretation of the Z coordinate. ^{A2}

5.7 The Image Information Block

The (^{AC3} 12 ^{AC3} byte) Image Information block is intended to describe digital properties of the facial image, one is included for each facial image included in the record. The structure of this block is shown in Figure 2. One Image Data block shall follow this block.

^{A2} 5.7.1 Face Image Type

The Face Image Type field shall represent the type of the facial image stored in the Image Information block and, if applicable, the 3D Data block according to Table 10. Note that all Frontal Image Types are either Full Frontal, Token Frontal, or one of the respective 3D Full Frontal or Token Frontal Image Types. Therefore a separate Frontal Value is not required.

Table 10 – Face Image Type codes

Description	Value
Basic	0x00
Full Frontal	0x01
Token Frontal	0x02
Reserved	0x03 – 0x7F
Basic 3D	0x80
Full Frontal 3D	0x81
Token Frontal 3D	0x82
Reserved	0x83 - 0xFF

The Basic Face Image Type is defined in clause 6. The Frontal, Frontal/Full and Frontal/Token Face Image Types are defined in clauses 7, 8, and 9 respectively. Face Image Types use the notion of inheritance. For example, the Frontal Face Image Type inherits all of the requirements of the Basic Face Image Type - the Frontal Face Image type obeys all normative requirements of the Basic Face Image Type. The inheritance structure of currently defined image types is shown in Figure 8. Relations are indicated by an arrow from the child to the parents.

If a 2D record that is compliant to the Basic, Full Frontal or Token Frontal requirements, respectively, contains 3D data, this is indicated by the highest bit of the Face Image Type set to one, resulting in the Face Image Type codes 0x80 to 0x82.

The 3D Image types are defined in clauses 10, 11, and 12 respectively. ^{A2}

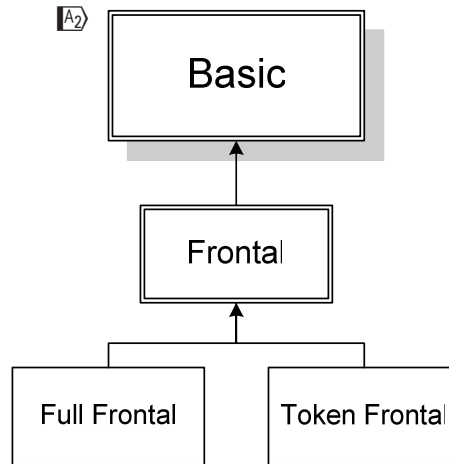


Figure 8 – 2D Face Image Types and their inheritance map. Normative requirements for the Basic, Frontal, Full Frontal and Token Frontal Face Images Types are given in clauses 6, 7, and 8, respectively. ^{A2}

5.7.2 Image Data Type

The (1 byte) Image Data Type field denotes the encoding type of the Image Data block. Either JPEG (ISO/IEC 10918-1 and ITU-T Rec. T.81) or JPEG2000 (ISO/IEC 15444-1) shall be specified. Note that a “Unspecified” Value cannot be encoded.

Table 11 – Image Data Type codes

Description	Value
JPEG	0x00
JPEG2000	0x01
Reserved	0x02 – 0xFF

5.7.3 Width

The (2-byte) Width field shall specify the number of pixels in the horizontal direction.

5.7.4 Height

The (2-byte) Height field shall specify the number of pixels in the vertical direction.

5.7.5 Image Colour Space

The (1 byte) Image Colour Space field indicates the colour space used in the encoded Image Data block according to the values in Table 12. The values of 128-255 are vendor specific. Application developers may obtain the values for these codes from the vendor.