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39794-16

First edition
2021-06

**Information technology — Extensible
biometric data interchange formats —
Part 16:
Full body 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 or www.iec.ch/members_experts/refdocs).

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

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

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

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

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

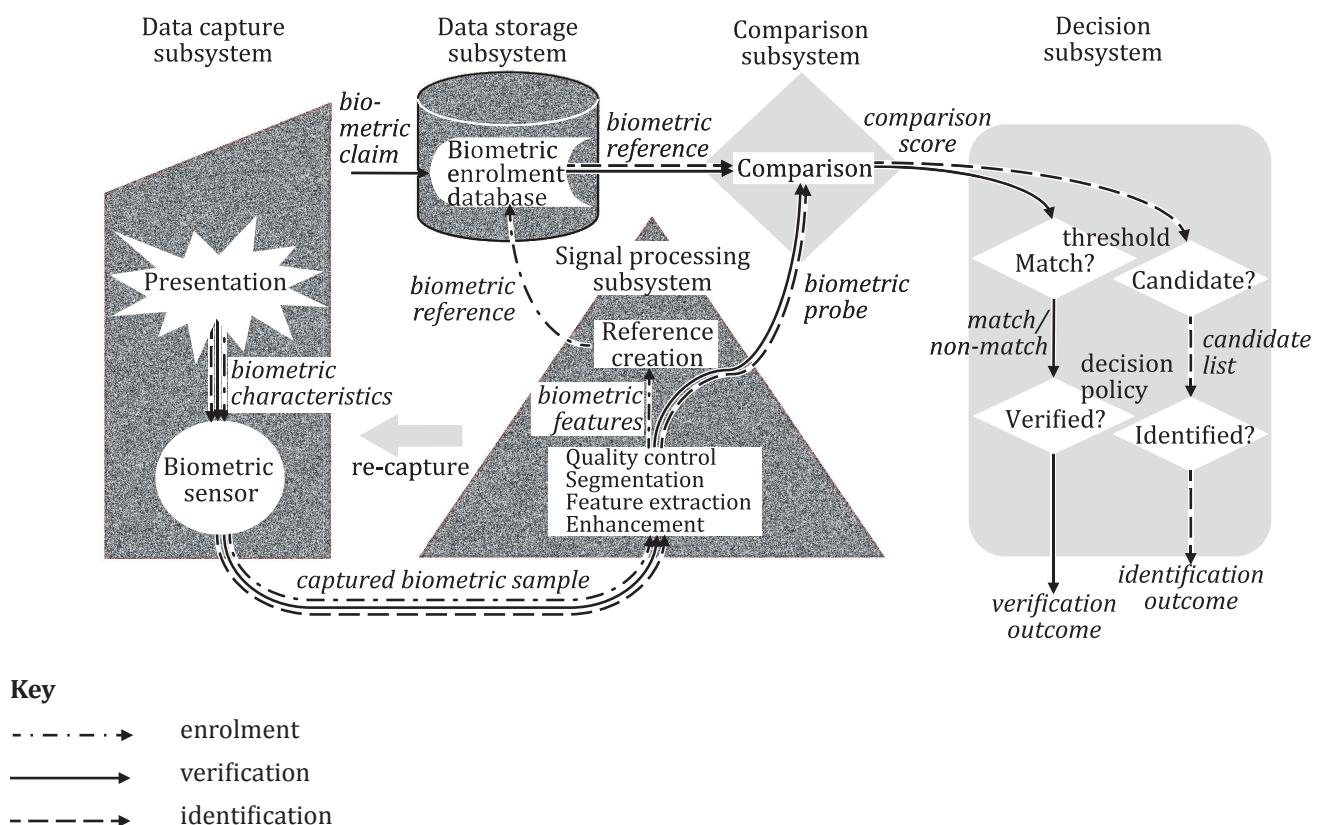
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Introduction

Most countries around the world use biometric recognition systems for law enforcement and border control. Many of these systems are not limited to face recognition purposes. To be consistent in such deployments and processes, technical documents, guidelines and best practice recommendations are being developed by different groups. These documents are primarily focused on the issuance and use of identity documents and related border control systems, and the technical and operational issues to be considered when planning and deploying them. "Face" is the biometric mode most suited to the practicalities of travel documents and automated border processing. "Full body" is a biometric mode that can be used in addition to face (for example, in border-crossing watchlist scenarios, crime surveillance, etc.). Full body can also be used in forensic scenarios.

There is very little guidance covering full body imaging for cross-border or law enforcement biometric recognition purposes. There is a need for guidance for the use of high-quality digital cameras and video surveillance devices, as well as guidance on full body data interchange structure semantics, syntax and format for the collection and use of full body image data in biometric recognition scenarios. A specific extensible biometric data interchange format for cross-border interoperability is required for full body images. Full body image data standardization is required to ensure threshold quality for database images for identification and verification using video surveillance and other similar system-generated images.

[Figure 1](#) illustrates components of a full body image biometric system on a checkered background.



NOTE [Figure 1](#) shows the information flow within a general biometric system, showing a general biometric system consisting of data capture, signal processing, data storage, comparison and decision subsystems. Each of these subsystems are defined in ISO/IEC 39794-1 in more detail.

Figure 1 — Components of a biometric system

Border personnel, immigration officials and police officers take full body images using local practices where no international standards are available to outline the practices which enable cross-border interoperability. This document can therefore be helpful for the description of the full body biometric characteristics and associated non-biometric information for identification purposes in disaster victim and law enforcement scenarios (e.g. victim identification, unknown bodies and missing individuals).

To enable applications on a wide variety of devices, including devices that have limited data storage, and to improve biometric recognition accuracy, other parts of the ISO/IEC 39794 series address data format, scene constraints (lighting, pose, expression, etc.), photographic properties (positioning, camera focus, etc.), and digital image attributes (image resolution, image size, etc.).

In order to fully understand the requirements implied in this document, it is recommended that the user become acquainted with certain other documents:

- ISO 22311: this document specifies a common output file format that can be extracted from the video-surveillance contents collection systems to perform necessary processing.
- The ISO/IEC 30137 series: this series specifies the use of biometrics in video surveillance systems.
- EN 62676^[22]: this document defines video surveillance systems for use in security applications.

This document (ISO/IEC 39794-16) is originally based on CEN/TS 17051.

Information technology — Extensible biometric data interchange formats —

Part 16: Full body image data

1 Scope

This document is intended to provide a generic extensible full body image data format for biometric recognition applications requiring exchange of human full body image data. Typical applications are:

- a) automated body biometric verification and identification of an unknown individual or cadaver (one-to-one as well as one-to-many comparison);
- b) support for human verification of identity by comparison of individuals against full body images; and
- c) support for human examination of full body images with sufficient resolution to allow a human examiner to verify identity or identify a living individual or a cadaver.

This document ensures that full human body images and image sequence data generated by video surveillance and other similar systems are suitable for identification and verification.

The structure of the data format in this document is compatible with ISO/IEC 39794-5. 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 a series of annexes.

The 3D encoding types "3D point map" and "range image" are not supported by 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) — Part 1: Specification of basic notation*

ISO/IEC 10918-1, *Information technology – Digital compression and coding of continuous-tone still images: Requirements and guidelines*

ISO 12052, *Health informatics — Digital imaging and communication in medicine (DICOM) including workflow and data management*

ISO 12233, *Photography — Electronic still picture imaging — Resolution and spatial frequency responses*

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

ISO/IEC 14496-10, *Information technology — Coding of audio-visual objects — Part 10: Advanced video coding*

ISO/IEC 14496-14, *Information technology — Coding of audio-visual objects — Part 14: MP4 file format*

ISO/IEC 15444-1, *Information technology — JPEG 2000 image coding system — Part 1: Core coding system*

ISO/IEC 15444-3, *Information technology — JPEG 2000 image coding system: Motion JPEG 2000 — Part 3*

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*

ISO/IEC 39794-5, *Information technology — Extensible biometric data interchange formats — Part 5: Face image data*

ITU-T Rec. T.81, *Information technology — Digital compression and coding of continuous-tone still images — Requirements and guidelines*

ITU-T Rec. T.802, *Information technology — JPEG 2000 image coding system: Motion JPEG 2000*

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

XML Schema Part 2: Datatypes Second Edition, W3C Recommendation, 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 and ISO/IEC 2382-37 and the following apply.

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

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

3.1

2D image

two-dimensional biometric capture *subject* (3.67) body representation that *encodes* (3.18) the luminance and/or colour variations of a biometric capture subject in a given lighting environment or a set of images recorded using required radiation bandwidths

3.2

3D shape

DEPRECATED 3D image

three-dimensional biometric capture *subject* (3.67) body representation that *encodes* (3.18) a surface or a volumetric shape in a 3D space

3.3

3D point map

3D point cloud representing a biometric capture *subject* (3.67), where each surface point is encoded with a triplet, representing the point as coordinate *values* (3.72) in a 3D *Cartesian coordinate system* (3.10) respectively

3.4

4K

UHDTV resolution of 3840 px × 2160 px to achieve a 16 × 9 aspect ratio

Note 1 to entry: UHDTV is an abbreviation for Ultra High Definition Television, defined in documents: SMPTE ST 2036-1 and Recommendation ITU-R BT.2020.

3.5**anthropometric landmark**

landmark point on the biometric capture *subject* (3.67) representation used for identification and classification of humans

3.6**artificial intelligence****AI**

discipline concerned with the building of computer systems that perform tasks requiring intelligence when performed by humans

3.7**biometric feature vector**

one-dimensional *matrix* (3.48) representation of biometric features

Note 1 to entry: Feature *vector* (3.73) is a list of numbers taken from the output of a *neural network* (3.51) layer or other biometric process capable of creating a one-dimensional matrix representation of biometric features.

3.8**cadaver**

dead body of a human

Note 1 to entry: The definition of "cadaver" does not include the dead body of an animal.

3.9**camera to subject distance****CSD**

distance between the eyes or the body surface plane of a capture *subject* (3.67) and the sensor/image plane of the camera

Note 1 to entry: In *full body images* (3.32) body surface plane is used when eyes plane is not visible.

3.10**Cartesian coordinate system**

3D orthogonal coordinate system

3.11**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 6 500 K

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

3.12**colour image**

continuous tone image (3.15) that has more than one channel, each of which is coded with one or multiple bits

3.13**colour space**

way of representing colours of pixels in an image

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

3.14**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

3.15

continuous-tone image

image whose channels have more than one bit per pixel

Note 1 to entry: An image, such as a photograph, where the grey levels in the image are continuous and not discrete.

3.16

Digital Imaging and Communications in Medicine

DICOM

standard for the communication and management of medical *imaging* ([3.41](#)) information and related data

Note 1 to entry: The DICOM Standard facilitates interoperability of medical imaging equipment.

Note 2 to entry: DICOM is defined in ISO 12052.

3.17

deoxyribo nucleic acid

DNA

complex molecule found in virtually every cell in the body that carries genetic information from one generation to another

3.18

encode

convert information into a coded form

3.19

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* ([3.25](#)) 12.1 and 12.2 as defined in ISO/IEC 14496-2.

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

3.20

eye to mouth distance

EMD

distance between the *face centre*, *M* ([3.22](#)), and the mouth midpoint

Note 1 to entry: This corresponds to *feature point* ([3.25](#)) 2.3 from ISO/IEC 14496-2.

3.21

f-stop

ratio of the lens focal length to the diameter of the entrance pupil

3.22

face centre

M

midpoint of the line connecting the two *eye centres* ([3.19](#))

3.23

face image

electronic image-based representation of the *portrait* ([3.55](#)) of a capture *subject* ([3.67](#))

3.24**facial animation parameter****FAP**

standard for virtual representation which includes visual speech intelligibility, mood and gesture by using *feature points* (3.25)

Note 1 to entry: This standard is specified in ISO/IEC 14496-1 and ISO/IEC 14496-2.

3.25**feature point**

reference point in a biometric capture *subject* (3.67) image as used by feature recognition algorithms

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

3.26**far-infrared****FIR**

section of infrared band with *wavelength* (3.74) from 50 µm - 1000 µm

Note 1 to entry: See ISO 20473.

3.27**fisheye**

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

3.28**forensic**

related to methods, techniques and processes used to establish conclusions and/or opinions, facts and findings, which can be used for legal proceedings[SOURCE: ISO 21043-1:2018, 3.14].

3.29**forensic analysis**

scientific tests or techniques used in connection with the detection of crime

3.30**Frankfurt Horizon****FH**

standard plane for orientation of the head

Note 1 to entry: The Frankfurt Horizon is defined by a line passing through the right trignon (the front of the ear) and the lowest point of the right eye socket. It can be hard to define, as it is related to the ear position, which can be covered by hair.

3.31**full body**

anatomical structure of an individual that includes any or all of the head, torso and limbs

Note 1 to entry: Full body refers to a living person or a dead body, and/or *personal data* (3.53) related to this full body.

3.32**full body image**

representation of a data *subject* (3.67) covering the *full body* (3.31)

Note 1 to entry: Full body image is not limited to the anatomical structure of the full body as the data subject refers to any individual person who can be identified, directly or indirectly, via an identifier such as a name, an ID number, location data, or via factors specific to the person's physical, physiological, genetic, mental, economic, cultural or social identity.

3.33**gait**

subject's (3.67) manner of walking

3.34

gamma rays

electromagnetic ionizing radiation, emitted by specific radioactive materials

EXAMPLE Cobalt-60 i.e. ^{60}Co .

Note 1 to entry: Gamma rays shall be used only to make examinations of non-living matter i.e. *cadavers* (3.8) or chemical traces.

[SOURCE: ISO 5576:1997, 2.61, modified — EXAMPLE and Note 1 to entry added.]

3.35

gradation

passing by small degrees from one tone or shade, as of colour, to another

3.36

greyscale image

continuous-tone image (3.15) encoded with one luminance channel

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

3.37

histogram

accurate representation of the distribution of numerical data

3.38

human body

data describing the anatomical structure of an individual that includes the head, torso and limbs

3.39

human examination

process of human comparison of the characteristics and structures in a biometric capture *subject* (3.67) image with those of an individual, or those in another biometric capture subject image

3.40

human verification

validation of the identity of a biometric capture *subject* (3.67) image by means of comparison with an individual or other biometric capture subject image

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

3.41

imaging

process of making a visual representation of something by scanning it with a detector or electromagnetic beam

Note 1 to entry: Biometric imaging can produce a feature *vector* (3.73) or feature *tensor* (3.68) of the biometric *subject* (3.67) instead of a visual representation.

3.42

inter eye distance

IED

length of the line connecting the *eye centres* (3.19) of the left and right eye

3.43

implementation under test

IUT

implementation of a technical system currently tested

3.44**lateral**

of, at, towards, or from the side or sides

3.45**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, and the first letter of subsequent words is uppercase

3.46**machine learning****ML**

process by which a functional unit improves its performance by acquiring new knowledge or skills, or by reorganizing existing knowledge or skills

Note 1 to entry: Machine learning is a form of computer *artificial intelligence* (3.6) that uses software based on concepts understood from biological *neural networks* (3.51) to adaptively perform a task.

3.47**magnetics**

science of magnetism used in Magnetic Resonance Imaging (MRI) utilizing the body's natural magnetic properties to produce detailed images from any part of the body

Note 1 to entry: Magnetism is a physical property of materials that causes forces between objects, either pulling them towards each other or pushing them apart.

Note 2 to entry: MRI is a non-invasive *imaging* (3.41) technology that produces three dimensional detailed anatomical images without the use of damaging radiation.

3.48**matrix**

an arrangement of numbers, symbols, etc. in rows and columns, treated as a single quantity

3.49**mid-infrared****MIR**

section of infrared band with *wavelength* (3.74) from 3 µm - 50 µm

Note 1 to entry: See ISO 20473.

3.50**near-infrared****NIR**

section of infrared band with *wavelength* (3.74) from 0,78 µm - 3 µm

Note 1 to entry: See ISO 20473.

3.51**neural network****NN**

artificial intelligence (3.6) technique that mimics the operation of the human brain

Note 1 to entry: In practice, the neural network is a network of primitive processing elements connected by weighted links with adjustable weights, in which each element produces a *value* (3.72) by applying a nonlinear function to its input values, and transmits it to other elements or presents it as an output value.

3.52

neutron

subatomic particles used for neutron *imaging* (3.41) (NI) purposes by the neutron attenuation process in a similar fashion to *X-rays* (3.76)

Note 1 to entry: Neutron imaging can be used to detect changes in hydrogen abundance that can be correlated with the *post-mortem* (3.57) interval, i.e. the time that has elapsed since a person has died.

3.53

personal data

information that relates to an identified or identifiable human being

3.54

Portable Network Graphics

lossless image compression standard

Note 1 to entry: This is specified in ISO/IEC 15948.

3.55

portrait

photograph of a capture *subject* (3.67) which includes the full head, with all hair in most cases, as well as neck and top of shoulders

Note 1 to entry: This can also refer to vertical camera orientation which is opposite to landscape orientation.

3.56

positron

positively charged subatomic particle used in the positron emission tomography (PET) *imaging* (3.41) technique

3.57

post-mortem

PM

after death

Note 1 to entry: Sometimes used to refer to examination or autopsy of a corpse in order to determine cause of death.

Note 2 to entry: Latin *post mortem*.

3.58

presentation attack

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

3.59

presentation attack detection

PAD

automated determination of a *presentation attack* (3.58)

3.60

proton

subatomic particles used in proton computed tomography (pCT, or Proton CT)

3.61

quantum

discrete quantity of energy, proportional in magnitude to the frequency of the radiation it represents

Note 1 to entry: This can also refer to the minimum amount of any physical entity involved in an interaction.

3.62**quantum entanglement**

phenomenon in *quantum* (3.61) mechanics in which a particle or system does not have a definite state but exists as an intermediate form of two 'entangled' states

Note 1 to entry: Quantum entanglement is a physical phenomenon which occurs when pairs or groups of particles are generated, interact, or share spatial proximity in ways such that the quantum state of each particle cannot be described independently of the state of the other(s), even when the particles are separated by a large distance. Instead, a quantum state is described for the system as a whole.

3.63**quantum sensor**

piece of equipment that exploits *quantum* (3.61) correlations, such as *quantum entanglement* (3.62), to achieve a sensitivity or resolution that is higher than using only classical systems

3.64**radial distortion**

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

3.65**range image**

numerical *matrix* (3.48) that *encodes* (3.18) a surface point in 3D space, where the position encodes the first two coordinates and the *value* (3.72) at that position encodes the third coordinate

3.66**submillimetre**

terahertz (THz) radiation, known as submillimetre radiation, consisting of electromagnetic waves within the ITU-designated band of frequencies from 0,3 THz to 3 THz (300 GHz - 3000 GHz)

3.67**subject**

person who is to be displayed on the image or from whom samples are to be taken

Note 1 to entry: A capture subject becomes a data subject when the subject's biometric samples are entered into a biometric system.

3.68**tensor**

mathematical object analogous to but more general than a *vector* (3.73), represented by an array of components that are functions of the coordinates of a space

3.69**texture image**

two-dimensional representation of the luminance and/or colour of a biometric capture *subject* (3.67) in a given lighting environment

3.70**ultraviolet radiation****UV**

wavelength (3.74) of the electromagnetic spectrum of radiation from 10 nm to 400 nm

[SOURCE: ISO 15858:2016, 3.3, modified — Note 1 to entry removed.]

3.71**upper camel-case notation**

naming convention in which compound words are joined together without spaces and the first letter of every word is uppercase

3.72**value**

numerical or categorical result assigned to a base measure, derived measure or indicator

3.73

vector

matrix (3.48) with one row or one column

3.74

wavelength

distance between repeating units of a wave pattern

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

3.75

white light

apparently colourless light

EXAMPLE Ordinary daylight.

Note 1 to entry: White light contains all the *wavelengths* (3.74) of the visible spectrum from 380 nm to 760 nm at equal intensity, based on human perception.

3.76

X-rays

penetrating electromagnetic radiation, within the approximate *wavelength* (3.74) range of 1 nm to 0,0001 nm, produced when high velocity electrons impinge on a metal target

Note 1 to entry: Wavelength range is from 10 nm to 0,001 nm according to ISO 21348.

[SOURCE: ISO 5576:1997, 2.129, modified — Note 1 to entry added.]

4 Abbreviated terms

2CIF	common interchange format 2 image format having width 704 pixels and height 288 pixels
4CIF	common interchange format 4 image format having width 704 pixels and height 576 pixels
ASN.1	abstract syntax notation one
AVC	advanced video coding
BAP	body animation parameters
BDB	biometric data block
BER	basic encoding rules
B&W	black and white
CAESAR	civilian American and European surface anthropometry resource
CBEFF	common biometric exchange formats framework
CEN	European Committee for Standardization
CIE	International Commission on Illumination (Commission Internationale de l'Eclairage)
CIEDE2000	CIE CIEDE2000 colour-difference formula defined in ISO/CIE 11664-6
CIELAB	CIE 1976 L*a*b* colour space defined in ISO/CIE 11664-4
CIF	common interchange format image format having width 352 pixels and height 288 pixels
CNN	convolutional neural network

CT	computed tomography
DCI	Digital Cinema Initiatives consortium
DER	distinguished encoding rules
DNA	deoxyribonucleic acid
DOF	depth-of-field
DSLR	digital single-lens reflex camera
DVI	disaster victim identification
EMD	eye to mouth distance
EV	exposure value
EXIF	exchangeable image file format
HD	high definition or horizontal deviation angle
HDR	high dynamic range
HDRI	high-dynamic-range imaging
Hex	hexadecimal
IBIA	International Biometrics + Identity Association
ICS	implementation conformance statement
INTERPOL	International Criminal Police Organization
IRI	international resource identifier
IUT	implementation under test
JFIF	JPEG file interchange format
JPEG	image compression standard specified as ISO/IEC 10918 NOTE The JPEG baseline standard was published as ISO/IEC 10918-1 and ITU-T Rec. T.81.
JPEG2000	image compression standard specified as ISO/IEC 15444 NOTE The JPEG2000 baseline standard was published as ISO/IEC 15444-1 and ITU-T Rec. T.800.
LED	light emitting diode
MeSH	medical subject headings resource ^[49]
MP4	digital multimedia file format used to store video and audio
MPEG	Moving Picture Experts Group
MRI	magnetic resonance imaging
MTF	modulation transfer function
MTF20	highest spatial frequency where the MTF is 20 % or above

NI	neutron imaging
NLM	United States National Library of Medicine
NTSC	National Television System Committee analogue television colour system
OWL	web ontology language
PAD	presentation attack detection
PAL	phase alternating line colour encoding system for analogue television
pCT	proton computed tomography
PET	positron-emission tomography
PNG	portable network graphics format specified in ISO/IEC 15948
QCIF	quarter common interchange format image format having width 176 pixels and height 144 pixels
RDB	relational database
RDF	resource description framework
RDFS	resource description framework schema
RFID	radio-frequency identification
RGB	red green blue colour representation
RIF	rule interchange format
SD	standard-definition television
SFR	spatial frequency response
SPARQL	standard protocol and RDF query language
sRGB	standard RGB colour space created for use on monitors, printers and the Internet using the ITU-R BT.709 primaries
SVGA	super video graphics array image format having width 800 pixels and height 600 pixels
THz	terahertz
TIFF	tagged image file format
UMLS	unified medical language system
URI	uniform resource identifier
URL	uniform resource locator
URN	uniform resource name
USAF	US Air Force
UTC	coordinated universal time
UTF-8	universal character set transformation format — 8-bit

VGA	video graphics array image format having width 640 pixels and height 480 pixels
WSVGA	wide super video graphics array image format having width 1024 pixels and height 576 pixels or 600 pixels
VUTOT	vermisste / unbekannte tote i.e. “missing or unknown dead (person)”
XDR	external data representation
XML	extensible markup language
XOP	XML-binary optimized packaging
XPath	XML path language
XSD	XML schema definition

5 Conformance

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

- its data structure, data values and the relationships between its data elements, as specified throughout [Clauses 7, 8, 9](#) and [Annex A](#) of this document;
- the relationship between its data values and the input biometric data from which the biometric data record was generated as specified throughout [Clauses 7, 8, 9](#) and [Annex A](#) of this document; and
- the application profile specific conformance specifications given in [C.4](#).

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

6 Modality specific information

6.1 Purpose

Within the context of full body imaging, there are certain generic requirements which are common to both face and full body. For example, most of the quality measures that are used to qualify perceived image degradation, compared to a reference standard quality image, are common to several modalities. In this case, such quality measures are image contrast, brightness, sharpness and illumination. Other common quality measures, also given in ISO/IEC 39794-5, include but are not limited to:

- a) Digital formatting of images, image resolution, and greyscale contrast.
- b) Scene deviation due to subject rotation, and illumination.
- c) Position of subject.
- d) Camera position, exposure, image brightness, focus and sharpness.

If a full body image is used to extract a passport quality face image, then the face image quality requirements defined in ISO/IEC 39794-5 shall be followed. For evaluation of the facial image quality for face recognition in video (FRiV), it is recommended to establish a multi-level evaluation methodology that is suitable for video surveillance applications^[48].

The use of "imaging" as a term within this document is intended to underline the specific nature of imaging requiring post-processing when compared to traditional white light photography.

6.2 Digital image encoding

For digital image encoding, one of four possible encodings shall be used:

- 1) The JPEG Sequential baseline format (ISO/IEC 10918-1), lossy or lossless, and encoded in the JFIF file format (the JPEG file format)^[35].
- 2) The JPEG-2000 Part-1 Code Stream Format (ISO/IEC 15444-1), lossy or lossless, and encoded in the JP2 file format (the JPEG2000 file format).
- 3) The PNG ISO/IEC 15948 format.
- 4) The MPEG-4 ISO/IEC 14496-2 format.

NOTE MP4 is a digital multimedia container file format for MPEG-4 as defined in ISO/IEC 14496-14.

The recorded image data shall appear to be the result of a capture process of a full body or a body part. 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.

Landmark points should be determined on images before compression is applied. Landmark points should be included in the record format if they have been accurately determined, thereby providing the option that these parameters do not have to be re-determined when the image is processed for body recognition tasks.

The Landmark points should be determined by computer-automated detection mechanisms followed by human validation. No recommendations are currently applicable for the landmark points.

NOTE JPEG File Interchange Format (JFIF) is a minimal file format which enables JPEG bitstreams to be exchanged between a wide variety of platforms and applications. Although any JPEG process is supported by the syntax of the JFIF it is strongly recommended that the JPEG baseline process be used for the purposes of file interchange as recommended by INTERPOL^{[28]-[29]}.

6.3 Photographic requirements and recommendations for white light imaging

6.3.1 General

This subclause specifies photographic constraints for the capture of white light post-processed images. Rather than imposing a particular hardware and lighting system, this clause specifies the type of output from these systems that is allowed. See [Annex E](#) for further guidance on making the required quality measurements.

6.3.2 Contrast and saturation

For each patch of skin on the subject, the gradations in luminance and hue shall be clearly visible, i.e. be of reasonable contrast. In this sense, there shall be no saturation (over or under exposure) on the subject.

The colour saturation of a 24-bit colour image should be such that after conversion to greyscale, there are at least 7 bits of intensity variation on the image.

6.3.3 Focus and depth of field

The subject's captured image shall always be in focus. Although this can result in the background behind the subject being out of focus, this is not a problem.

NOTE In a typical photographic situation, the f-stop of the lens is set at two (or more) f-stops below the maximum aperture opening when possible to obtain enough DOF.

All images shall have sufficient depth of focus to maintain greater than 2 mm spatial sampling rate on the subject's features at time of capture.

Greater than 1 mm spatial sampling rate is considered to have been accomplished if the individual millimetre markings of rulers placed on the subject facing the camera are visible simultaneously in a captured test image.

If the camera lacks auto focus, all subject positions shall be maintained in a defined area for all image captures.

6.3.4 Greyscale density

The dynamic range of the image should have at least 7 bits of intensity variation (span a range of at least 128 unique values). This recommendation can require camera settings to be changed on an individual basis when the subject is significantly lighter or darker than the average subject.

If required in a forensic examination environment, it is recommended to use high-dynamic-range imaging (HDRI), which is a high dynamic range (HDR) technique used in imaging and photography to reproduce a greater dynamic range of luminosity than is possible with standard digital imaging or photographic techniques.

6.3.5 Colour

Unnaturally coloured lighting (yellow, red, etc.) shall not be used. Care shall be taken to correct the "white balance" of image capture devices. Photographs should use colour-balancing techniques such as using xenon flash or high colour quality led lights.

A process that overexposes or under-develops a colour or greyscale image for purposes of beauty enhancement or artistic pleasure is not allowed. The full spectrum shall be represented on the image where appropriate.

Colour calibration using an 18 % grey background or other method (such as white balancing) is recommended.

6.3.6 Radial distortion of the camera lens

The 'fisheye' effect associated with wide angle lenses and which can result in the subject appearing to have an unusually large nose in the image shall not be present.

While some distortion is almost always present during photography, that distortion should not be noticeable by human examination.

The purpose of this requirement is to reduce variations in radial distortion between images due to differing focal lengths. For a typical biometric capture system with a subject 1,5 to 4 meters from the camera, the focal length of the camera lens should be 50 mm or more for 35 mm compatible (i.e. full frame) photography.

6.4 Digital requirements and recommendations for images

6.4.1 General

This subclause specifies digital requirements for digital camera image geometry, colour representation and image formatting. See [Annex E](#) for greyscale and colour-checking using IEC 61966-8^[24] test charts.

6.4.2 Geometry

Digital cameras shall produce images with a pixel aspect ratio of 1:1.

The origin of coordinates shall be at the upper left given by coordinate (0,0) with positive entries from left to right (first dimension) and top to bottom (second dimension).

6.4.3 Colour

Post-processed images shall be represented as one of the following:

- a) The 24-bit RGB colour space where for every pixel, eight (8) bits are used to represent each of the Red, Green, and Blue components.
- b) An 8-bit monochrome colour space where for every pixel, (8) bits are used to represent the luminance component.
- c) The YUV422 colour space where twice as many bits are dedicated to luminance as to each of the two-colour components. YUV422 images typically contain two 8-bit Y samples along with one 8-bit sample of each of U and V in every four bytes.

To achieve device-independence, the RGB values from the camera should be converted to values in a defined standard RGB space, such as sRGB^[19], using the device's colour profile and colour management processing. Information regarding device profiling and colour management can be downloaded from the International Color Consortium URL^[29].

All interlacing shall be absent (not simply removed, but absent).

6.4.4 Formatting requirements and recommendations

As biometric comparison subsystems can be very sensitive to image artefacts caused by post-processing, for interoperability reasons the original image should be stored in addition to the processed image.

If the receiver of an interchange record containing post-processed image data has better technology than the encoder of this record they can still rely on the original image data.

To encode the relationship between the different representations, the Derived from element shall be used. Multiple cross-referencing of one original representation is possible. Furthermore, the representation identifier element of the original image shall be present.

The post-acquisition processing element shall be present.

6.5 Recommendations for full body image data systems

6.5.1 General

This subclause describes architectural aspects, usability and accessibility considerations. Rather than imposing a particular system architecture, this subclause presents practical applications and recommendations.

6.5.2 Architecture

The architectural aspects that can be considered by the definition of full body image data system architecture are:

- biometric capture sub-processing, carried out by a biometric capture device;
- image formatting sub-processing, carried out by a biometric capture subsystem;
- visualization of process and results, both for operator and the subject of biometric processes;
- integrity of full body image data system;
- security of the system to ensure only authorized access, use, disclosure and disposal of biometric and related data records is possible; and
- connection to other systems (databases, etc.) with the focus on protocols and the integrity of such connections.

Only the first two aspects are within the scope of this document. The other aspects are covered in documents listed in the Bibliography.

6.5.3 Usability and accessibility

Biometric systems should be designed to be accessible for all, including those that have disabilities, or special needs. For subjects that cannot use a biometric system, alternatives should be provided.

General guidance on these aspects is given in ISO/IEC TR 24714-1. Pictogram recommendations can be found in the ISO/IEC 24779 series.

6.5.4 Practical applications

In practice, full body images and videos of crime suspects are collected using a biometric capture process. This process can involve one or more high resolution biometric capture devices, including 4K video devices. Biometric features are extracted from the captured biometric samples to generate a biometric reference. This reference is stored for use in subsequent biometric comparisons.

In automated systems, it is possible to create a biometric reference from a biometric probe captured during routine surveillance. In crime scenarios, such a probe-based reference shall be marked in the personal data basic data element (nature of disaster sub-element) as a crime suspect.

Depending on the cultural requirements, individuals are photographed wearing clothing or near naked. According to INTERPOL Disaster Victim Identification guidelines^[28], photographic and video recording of bodies at the disaster site and within the mortuary is important both for evidence and because it can help to establish the cause of the incident.

INTERPOL photographic documentation recommendations for bodies and/or body parts^[29] are as follows:

- a) Digital cameras should be used wherever possible.
- b) Body numbers should be clearly visible on each photograph.
- c) Dirt on faces and clothing should be removed.

The following photographs should be taken:

- 1) Photograph of the entire body.
- 2) Photograph of the face.
- 3) Photograph of the torso.

4) Photograph of the lower body.

State-of-the-art image recognition algorithms can be used to select images of people with almost no useful identity information in the face. Recognition of the face alone in these cases are near chance level, but recognition of the individual based on a larger part of the body presents a significantly higher level of accuracy, according to research carried out at the University of Texas in Dallas^[35].

Body images appear in video surveillance videos more often than clear face images. Faces and body images are added to watch lists (for example, in border-crossing watchlist scenarios) from observation of behaviours in video material. A standard has been created describing the biometric sample formats for full body images in order to increase the international interoperability of biometric samples.

SD video frame comparison with high quality reference images gives better results than comparing two SD level images. 4K DSLRs capable of taking high resolution still images and 4K video are currently available at a reasonable price. Video surveillance systems are likely evolve from HD to 4K in the near future and therefore the resolution level of still images should be high. A passport-quality face image is obtained by cropping the 4K full body frontal image of an individual.

Annotation data formats for biometrics in video surveillance systems (ISO/IEC 30137-4) and high efficiency coding (ISO/IEC 23008-12) are standardized for data format integration work.

6.6 Full body imaging technical requirements

6.6.1 General

This subclause specifies technical requirements for optical distortion and colour fidelity and shows examples of full body photographs. The colour fidelity is extended to cover non-visual wavelengths in addition to visual wavelengths.

6.6.2 Optical distortion

Radial distortion due to lens properties can be noticeable to human examiners. In particular, fisheye effects caused by wide angle lenses combined with camera placement too close to the subject's body shall not be present.

If the radial distortion is less than 2 %, the human eye cannot easily perceive it. It is recommended that radial distortion be less than 2,5 %.

The general assessment of an optical system is discussed in [Annex E](#).

6.6.3 Colour fidelity

The image shall be colour neutral and correctly exposed. It is important that the boundary between the whole body and the background should be clearly identifiable about the entire subject. There should be no shadows visible on the background behind the body image. The background should be plain and should contain no dots, lines or curves that can cause computer pattern recognition algorithms to become confused. Therefore, the background should be a uniform colour or a single colour pattern with gradual changes from light to dark luminosity in a single direction.

Full body imaging covers both visual and non-visual wavelengths^[45]. Infrared covering both near and far infrared wavelengths and millimetre wavelength imaging covering both passive and active systems in submillimetre and millimetre wavelengths are in use. In full body imaging, both still and video recordings are made for enrolment, verification and identification purposes.

[Figure 2](#) illustrates the wavelengths commonly used in biometric imaging. In [Figure 2](#), wavelengths start from visual light (marked with rainbow) wavelengths between 400 nm and 700 nm and go down to millimetre waves.

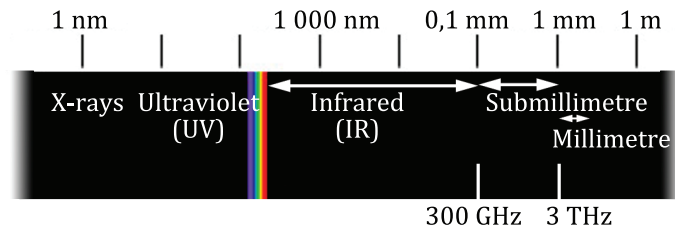


Figure 2 — Wavelengths commonly used in biometric imaging

Note that ionizing X-rays or UV radiation should not be used for living human tissue biometrics.

The UV radiation range between 100 nm and 400 nm is commonly subdivided into:

- UVA: 315 nm to 400 nm;
- UVB: 280 nm to 315 nm;
- UVC: 200 nm to 280 nm;
- Vacuum UV: 100 nm to 200 nm.

UVC radiation is a low-penetrating form of UV as compared to UVA or UVB radiation. Measurements of human tissue show that 4 % to 7 % of UVC radiation, along with a wide range of wavelengths from 250 nm to 400 nm, is reflected and absorbed in the first 2 μm of the stratum corneum. Hence, the amount of UVC transmitted through the epidermis is minimized.

Stratum corneum is the outermost layer of the epidermis, consisting of dead cells (corneocytes). UVA and UVB both contribute to sunburn, skin ageing, eye damage and melanoma and other skin cancers.

6.6.4 Example full body photographs

The light source type used in full body photography depends on the photographic needs. Electronic flash units are suitable for still photography. Video recording is carried out using either high quality LED-panels or similar high-quality video lights. A test chart shall be used to measure colour accuracy as shown in [Annex E](#).

The following examples portrayed in [Figure 3](#) and [Figure 4](#) are produced in a full body photography studio.

[Figure 3](#) illustrates different background types. [Figure 3a](#)) shows a photograph with a high-quality background, and [Figure 3b](#)) shows the same photograph posterized with 4 steps. Posterization of an image entails conversion of a continuous gradation of tone to several regions of fewer tones, with

abrupt changes from one tone to another. Posterizing the levels of brightness to 4 gives a good estimate of the light distribution on the subject.

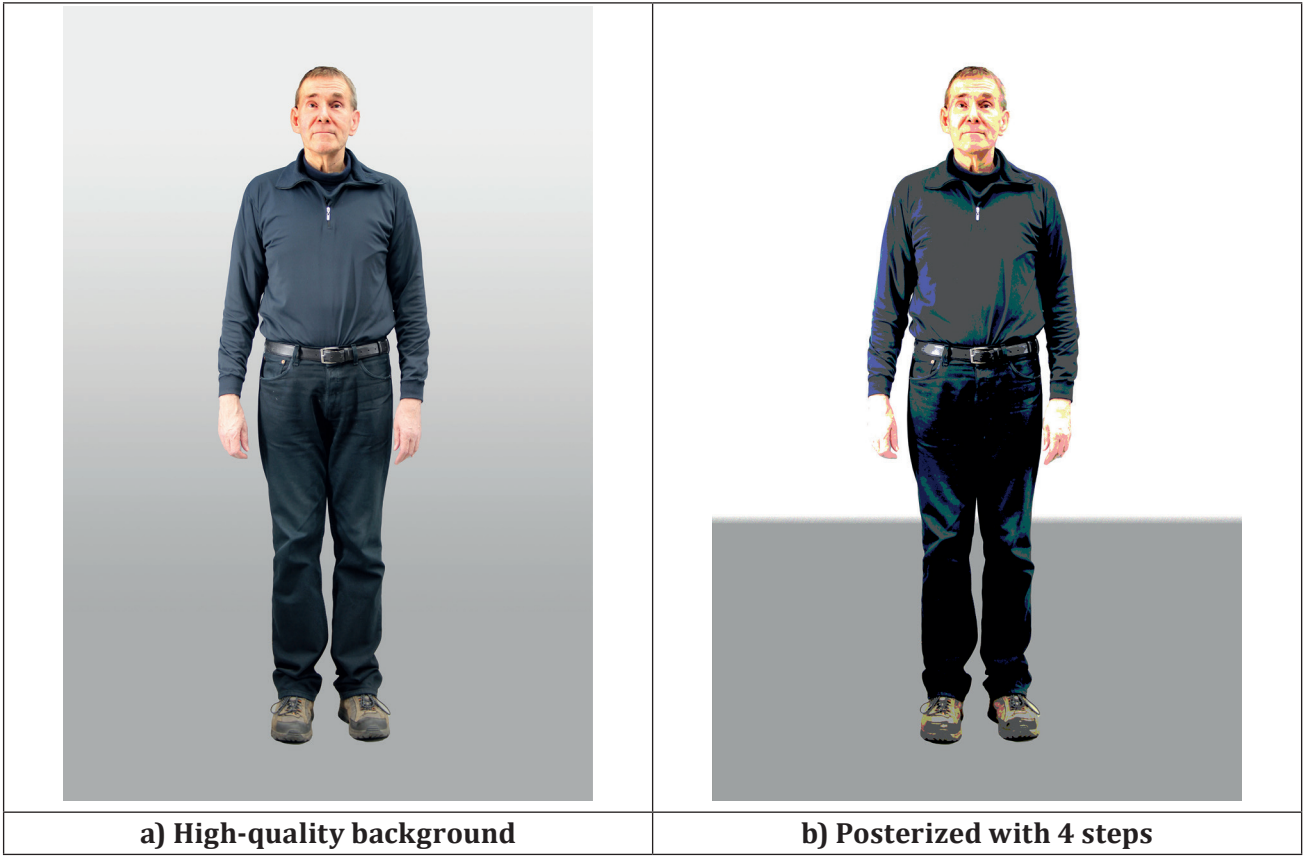


Figure 3 — Full body photographs

If the facial area and the rest of the body is illuminated evenly, then the light and dark areas cover the whole body evenly.

Figure 4 illustrates full body photographs showing the floor border [Figure 4a)] and unwanted objects marked with X [Figure 4b)]. All background objects are unwanted.

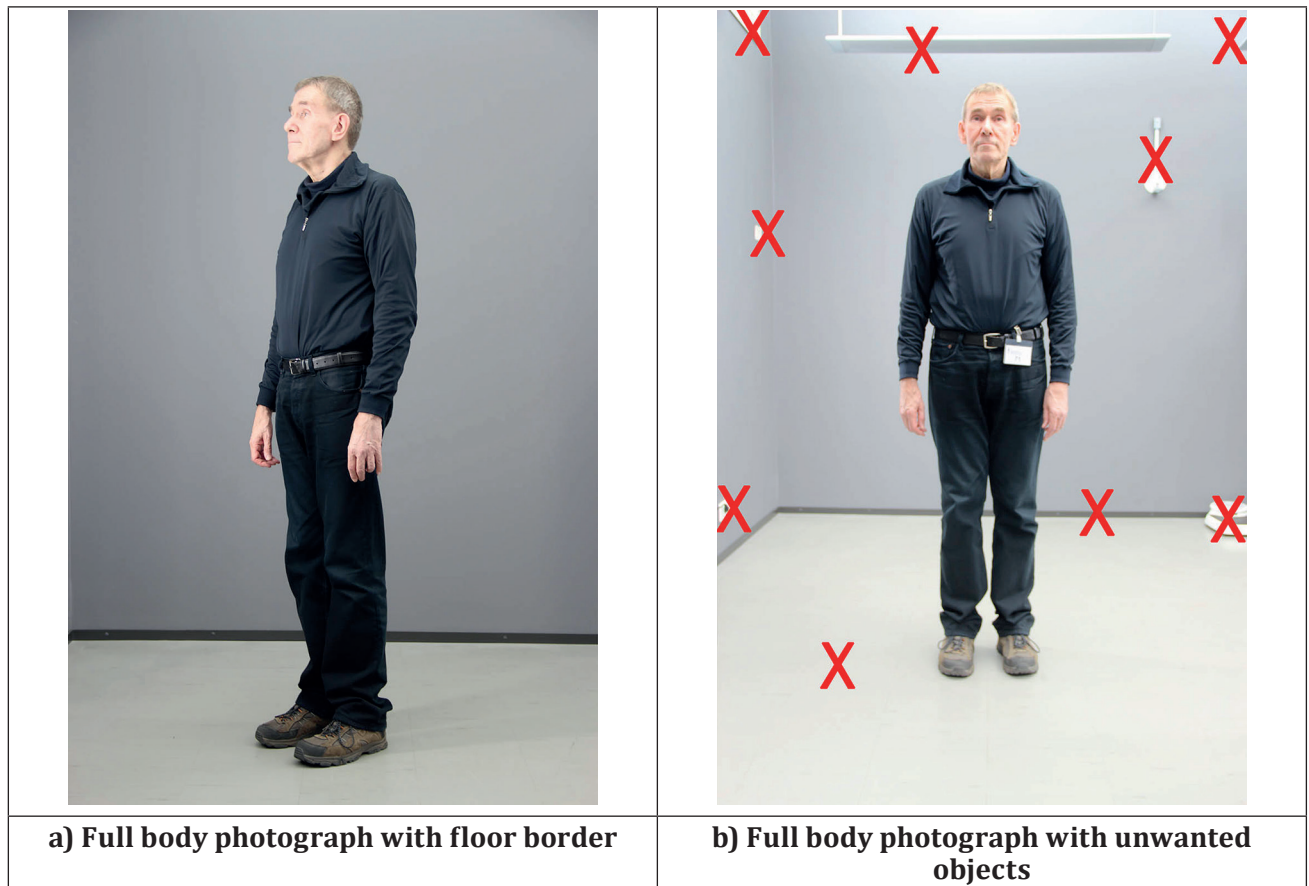


Figure 4 — Full body photographs with unwanted background objects

In Figure 4a), there is a light shadow on the floor. All shadows should be minimized by adjusting the lighting. Floor borders should also be omitted and the wall and floor should be of the same plain colour.

6.7 Full body photography session

6.7.1 General

This subclause describes a typical workflow for a full body photography session and specifies content requirements for full body photographs.

6.7.2 Typical workflow for full body photography session

Proper positioning of the subject and control of the subject's pose can be improved through feedback to the operator via a live-video showing the subject during the capture process. Previewing of the captured image should be provided to allow the subject to be recaptured before the image is submitted for further processing. In legacy systems, pose-aware subject recognition^[47] can not be available and therefore proper positioning is required.

The subject shall stay in a natural pose while being photographed. Standing straight is not natural for some people so such poses are not to be forced. It is good practice to take pictures using 45° steps in yaw angle.

The subject's clothing shall not hide body features as loose garments do not show enough bodily contour points for gait and posture silhouette matching. The hands shall be freely kept at the sides of the body in a natural hanging posture unless the subject is unable to do so because of medical reasons^[40].

Notes should be taken regarding the subject's distinguishing features and assumed state of mind. The subject's state of mind has an effect on posture. For gait recognition, notes should also be taken regarding ailments in the skeletal system. In particular, arthritis and problems moving legs and hands should be carefully documented.

When retaking pictures of a subject who has been documented before, it is important to note the differences from the previous pictures and the associated documentation.

When the subject is wearing a scarf or other religion-related garment it is necessary to take into account the limitations posed by the religion and never insult the subject or undermine the cultural restrictions. When the cultural and religious rules demand the absence of the opposing gender in the same room then this shall be taken into account.

6.7.3 Full body photograph content requirements

The following requirements are applicable to full body photograph contents:

- 1) details shall be in focus;
- 2) camera height shall be kept at the level of the subject's navel;
- 3) the subject shall be centred on the viewfinder;
- 4) enough background shall be shown around the subject's body in the image to allow for automatic contour cropping^[37];
- 5) the individual's whole body shall be visible on all images taken;
- 6) the subject shall be asked to wear indoor clothing;
- 7) the subject shall be encouraged to relax so that the pose is more natural;
- 8) the subject shall be instructed to keep their hands at their sides if possible;
- 9) if the subject is wearing a wig or similar head covering, then the images shall be taken with and without the said covering; and
- 10) the medical limitations of the subject shall be taken into account.

6.8 Photo studio recommendations for full body photography

6.8.1 General

This subclause gives guidance concerning the positioning of the subject and camera, as well as examples of lighting arrangements. The intention of this guidance is to ensure that the subject's full body is properly positioned and uniformly illuminated, thereby producing images that are conformant with this document and are without shadows or hot spots on any part of the body.

Distortion that is noticeable by human examination shall not be present. In particular fisheye effects caused by wide angle lenses combined with too close camera placement shall not be present.

A photo studio is typically a professionally operated facility, equipped with a digital camera, multiple adjustable light sources, a suitable background or backdrop cloth, and subject positioning apparatus designed to obtain high quality full body images. This section provides expert guidance for the owners and operators of such facilities when they produce photographs conformant with the requirements of this document.

6.8.2 Recommended camera orientation and margins

It is recommended to take pictures using vertical camera orientation. The original camera image is saved whenever possible without any additional cropping, rotation or other image processing. The full body pose shall be between 60 % and 95 % of the vertical length of the image. The whole-body height and width shall be visible.

Vertical orientation of the camera is recommended for full body images for two reasons:

- vertical orientation allows the use of available pixels in an economical manner; and
- vertical camera orientation gives Level-51/52 results when using an 8 megapixel camera and Level-50 results when using a 15 megapixel camera.

6.8.3 Recommended positioning and distance between camera and subject

The following recommendations concern the positioning of the full body subject and the camera. If full body image is used also for face image then it is recommended to take two pictures: one for the full body and at least one for the face based on the face image requirements[2].

- the camera lens distance from the floor should be 1 m for full body photographs;
- the camera lens focal length should be in the order of 50 mm measured with a full-frame 35 mm digital camera in vertical orientation for 4 m subject distance for full body photographs;
- arranging the lighting without creating shadows is difficult if the surface area of the light source is small compared to the size of the body surface. Ideal light source length is approximately the same as the body length. A large radiating surface allows the positioning of the lights much nearer to the camera than is otherwise possible; and
- proper focus and DOF is assured by pre-focusing the lens at the distance of the subject's front and by selecting an appropriate aperture (f-stop) to ensure a DOF of at least 15 cm, or approximately the distance from a subject's nose to ears. The DOF of a lens is dependent upon its focal length, its effective aperture, and the focus distance. For practical purposes aperture values between f/5,6 and f/11 produce good DOF results for 50-85 mm lenses.

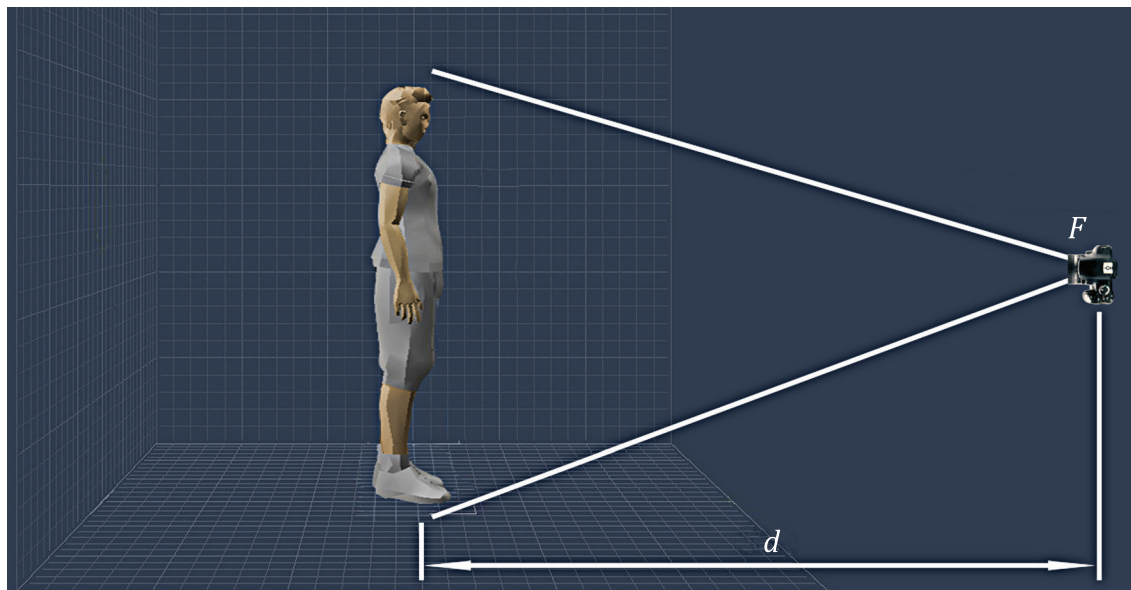
A normal lens is a lens that reproduces a field of view that generally looks "natural" to a human observer under normal viewing conditions. Normal lens focal lengths are considered to be between 40 mm and 55 mm.

EXAMPLE Consider a 35 mm (i.e. full frame) camera with a lens having a focal length, F , of 50 mm. The dimensions of the full frame image are 24 mm × 36 mm, giving a vertical camera orientation maximum vertical angle at infinity focus, $f = F$:

$$\alpha_h = 2 \arctan \frac{h}{2f} = 2 \arctan \frac{36}{2 \times 50} \approx 39.6^\circ$$

According to this calculation, a 50 mm normal lens vertical camera orientation vertical viewing angle is 39,6° when used with 36 mm × 24 mm format (that is, 135 film or full-frame 35 mm digital). Using this angle for a 2 m high subject, a full body image camera is subject to a minimum distance of 3 m when a 50 mm lens is in use. It is recommended to keep the distance from the subject to the camera at 4 m or more in order to assure good image cropping in all focusing situations. Use the camera lens focal length conversion factor to find the full frame compatible focal length for calculations. The multiplication factor is usually 1,5 or 1,6 for APS-C sensor cameras.

[Figure 5](#) illustrates the relationship between the camera focal length and the distance from the subject to the camera.

**Key** F 50 mm lens focal length d 4 m distance**Figure 5 — Positions of subject and camera****6.8.4 Recommended focusing settings**

Proper focus and DOF are assured by either using the camera auto focus function with manual aperture settings or by pre-focusing the lens at the distance of the subject's eyes. Selecting an appropriate aperture (f-stop) between $f/5,6$ and $f/11$ ensures a DOF of the distance from a subject's nose to ears. That is in most cases approximately 15 centimetres, which is sufficient.

6.8.5 Recommended white balance settings for white light imaging

White balance settings on the camera shall be properly set in order to achieve high fidelity skin tones. In order to assure the required image quality, system installers shall make quality assurance measurements of light conditions and camera system response. This shall be when a recommended CIE Standard Illuminant D65 high quality illuminant or similar continuous spectrum daylight illuminant (4 500 - 6 000 K) camera and control software is used. In practice it is necessary to reduce the ambient light pollution emanating from uncontrolled daylight sources, fluorescent or similar light sources and reflections from surfaces.

Imaging fidelity measurements for photo studio and stationary registration office installations can be done either using a light spectrum analyzer to define the spectral characteristics of the illuminants or analyzing measurement target images using software applications. For mobile registration office imaging, automatic white balance setting procedures and quality analysis should be used to ensure a high level of image conformance.

6.8.6 Recommended backdrop design

A continuous backdrop should be placed behind the subject in order to create a single colour pattern with gradual changes from light to dark luminosity in a single direction. In selecting the backdrop lightness, it is recommended to select a grey level that provides sufficient distinction between the subject and the background. It is recommended to use a light grey background with a plain, smooth surface.

[Figure 6](#) illustrates the hanging of a seamless background.

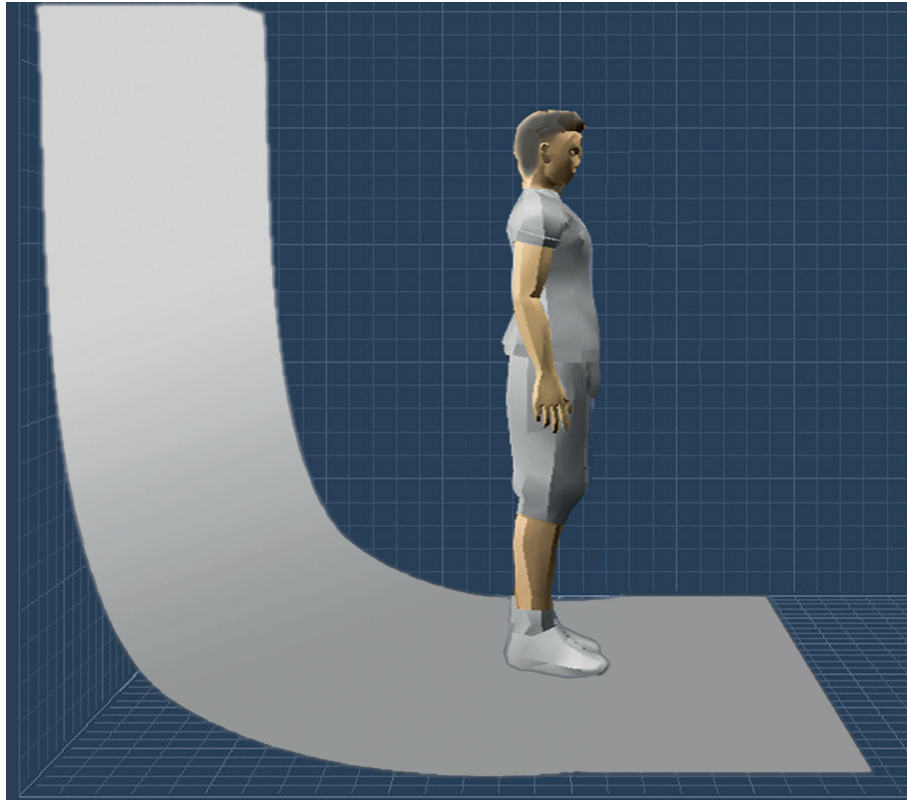


Figure 6 — Backdrop alignment

6.8.7 Example configurations for a photo studio

[Figure 7](#) is showing minimum recommended measurements for the full body photography studio when using large surface light sources. Gait recognition walk through video recordings can require more horizontal space.

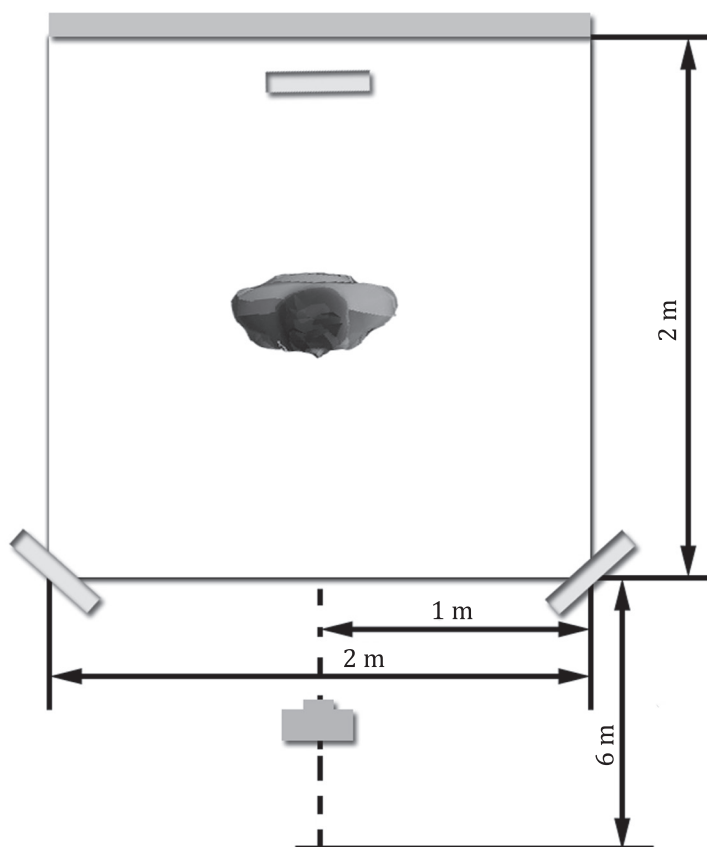


Figure 7 — Minimum recommended measurements

The use of a treadmill for a small recording studio setup is recommended to achieve good quality gait recognition recordings^[39].

When setting up a studio, consideration should be given to safety and security measures to minimize the risk of injury or death. For example, the subject should always be located so that it is possible for the operator to evacuate the studio room through a door behind the operator. This arrangement is important especially in prisons, police stations and similar facilities.

6.8.8 Basic fidelity image test for white light imaging

[Figure 8](#) demonstrates the visual fidelity test method. Basic camera image fidelity test is performed by taking a full body image of a test subject in the studio. The camera image is then enlarged using an application available for image viewing or editing found in the operating system on all computers.

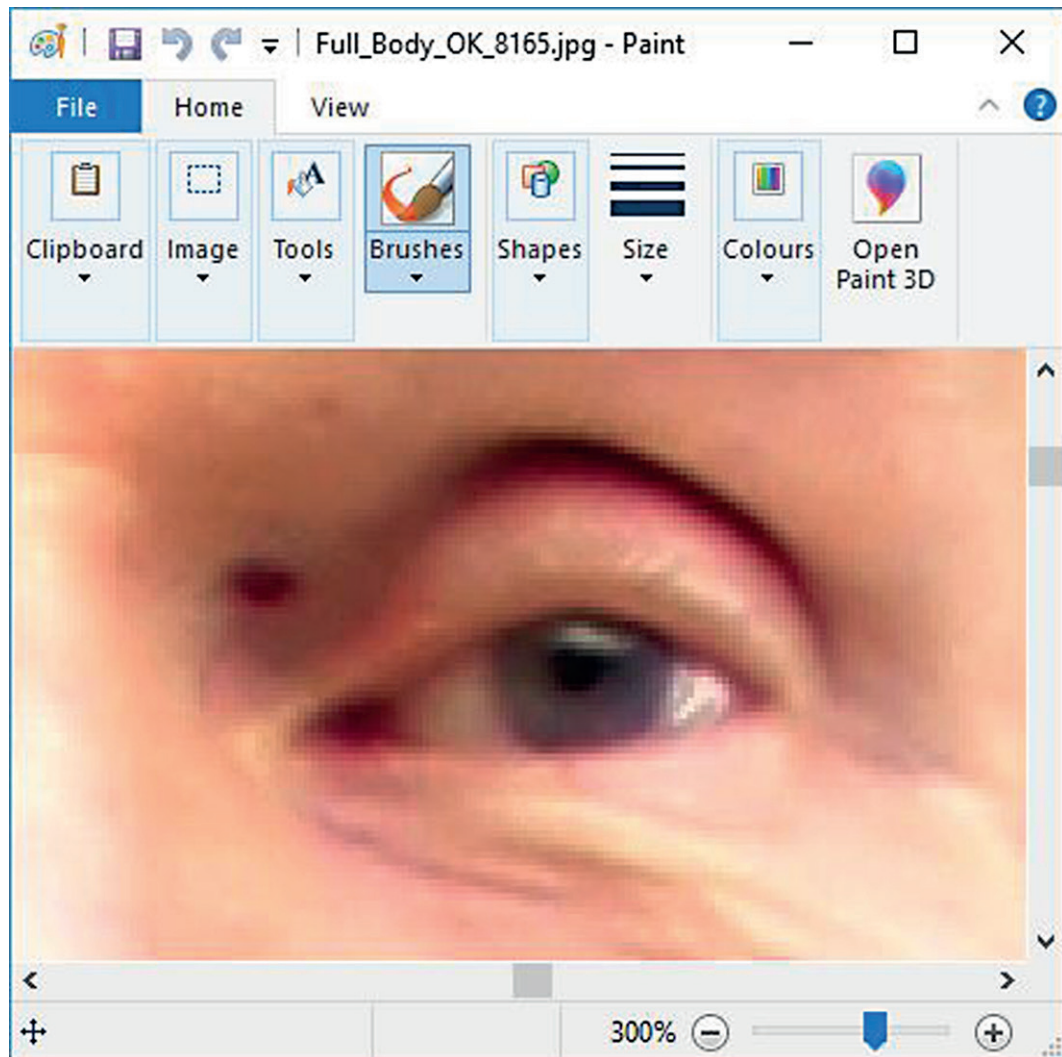


Figure 8 — Basic camera image fidelity test

The test image shall clearly show the pupil and iris of an eye when enlarged in the image editing or viewing application. Skin shall appear the same as when looking at the test subject and there should be fine contrasted face details, such as wrinkles and moles, as small as 1 mm in diameter visible on the image. This basic fidelity test is simple to perform and ensures that all settings are in order, i.e. camera is focused properly and white balance is showing the skin tone correctly.

6.9 Non-white light or multispectral imaging

6.9.1 General

Non-white light refers to wavelengths outside of the white light wavelength range. Multispectral imaging is operating in or involving several regions of the electromagnetic spectrum.

The requirements described in 6.3 and 6.4 also apply to non-white light and multispectral imaging when the imaging result is a picture excluding the colour requirements. Single wavelength band images are rendered using 8-bit monochrome colour space, where for every pixel, 8 bits are used to represent the luminance component. Colour in multispectral imaging is selected using a false colour substitute selected from the visual colour palette, e.g. deep red for infra red wavelengths. However, biometric multispectral imaging may produce a biometric feature vector or tensor of the biometric subject instead of a visual representation. It is possible to render an image based on the biometric feature

vector or tensor applying the requirements and recommendations of this document. For information interchange, the image format shall comply with one of the encodings given in [6.2](#).

6.9.2 Infrared imaging

An infrared energy source emits radiation that falls on the subject. In a camera able to take images using both infrared and visible light, it is necessary to place a barrier filter over the lens to prevent the visible light from passing through the lens when taking infrared images.

Luminescence occurs when certain materials emit infrared radiation caused by a shorter wavelength of visible light or ultraviolet radiation falling on the material. Luminescence is the spontaneous emission of light by a substance not resulting from heat. Fluorescence is the emission of light by a substance that has absorbed light or other electromagnetic radiation. It is a form of luminescence.

Visible light masks the effect of the luminescence on the digital sensor. Two filters are necessary to prevent this from occurring when using fluorescence. A blue green filter sometimes referred to as an exciter filter is placed over the multispectral light source. This limits the incident radiation to shorter wavelengths of light preventing any infrared radiation emitted by the energy source from falling on the subject. The second filter, referred to as a barrier filter is placed over the lens to prevent the visible light from passing through the lens.

Reflected infrared full body photography is useful for differentiating between parts of clothing that look the same in visible light but are actually different. In some cases, visibly dark or even black cloth can be rendered nearly white. Substances such as blood patterns are then revealed. Reducing backgrounds to reveal the presence of stains is a common application for infrared reflected photography.

[Figures 9](#) and [10](#) illustrate the difference between visual wavelength and infrared photographs.

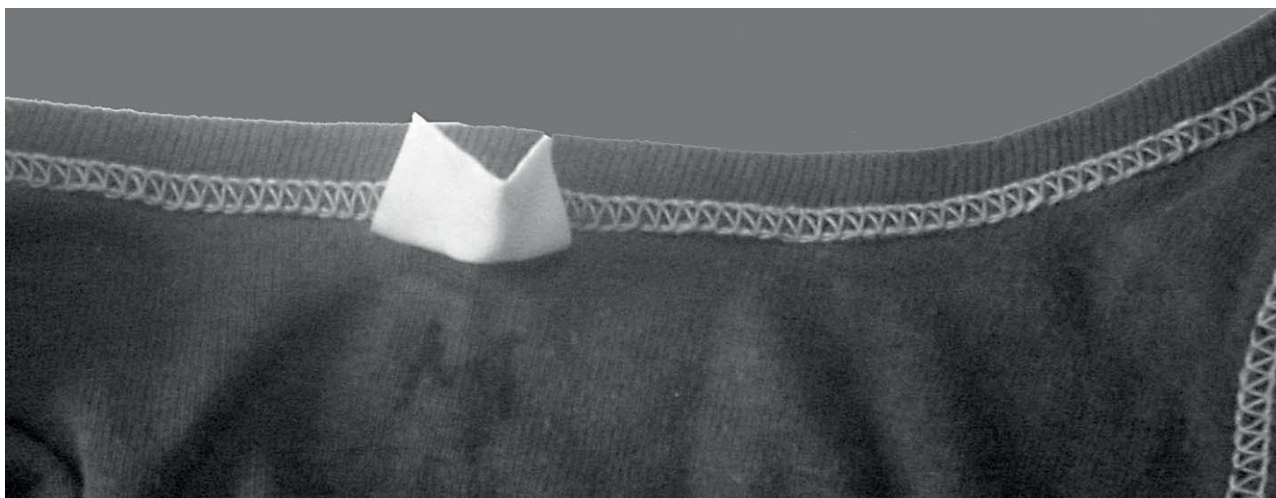


Figure 9 — Infrared image of a T-shirt



Figure 10 — White light photograph of a T-shirt

In [Figure 9](#) the infrared image of a T-shirt is clearly showing the letter M under the white tag but in the white light photograph in [Figure 10](#) the letter M marking is invisible. Stitches are seen in detail in the IR image.

6.9.3 Ultraviolet imaging

Reflected UV imaging is the only way to visualize certain phenomena, such as faint traces of substances on surfaces or the surface details on certain transparent materials. For example, imaging explosives residue or substances that are transparent to the eye and near-IR imaging become visible when UV is used for imaging. UVA, UVB, and UVC wavebands are useful because they allow the user to visualize evidence that is usually difficult or impossible to record with other imaging techniques.

The standard digital cameras do not respond to ultraviolet light to be used in forensics. Some specially modified digital single-lens reflex cameras (DSLRs) can be used for UVA photography. Cameras shall be used with bandpass filters to record UVA unless the lighting is pure UVA, with little or no visible light or IR present.

It is important to use the right wavelength of UV light for forensic imaging. Beware of any vendor of UV LED illuminators that is not explicit about the wavelength of their lights.

6.10 Submillimetre imaging

Terahertz (THz) radiation, known as submillimetre radiation, consists of electromagnetic waves within the ITU-designated band of frequencies from 0,3 to 3 terahertz (300-3000 GHz). Wavelengths of radiation in the terahertz band correspondingly range from 1 mm to 0,1 mm and this wavelength also sets the theoretical resolution limit for the images. Terahertz radiation is located in the terahertz gap between microwaves and infrared light waves in the electromagnetic spectrum.

Imagers in this document are divided into two main categories: active and passive systems. The active imagers are based on a radar configuration, with synthetic or optical imaging schemes, whereas passive ones operate as cameras. The main challenge in all these systems is to achieve a large field of view (FOV) with satisfactory spatial resolution and fast image acquisition.

[Figure 11](#) shows an identifiable Apache-SMG submachine gun hidden under subject's clothing. When object outlines are clearly visible then it is possible to react to the danger in a proper way.



Figure 11 — Submillimetre image showing a gun hidden under subject's clothing

A THz beam can traverse non-metallic materials like clothing fabrics, paper and cardboard, plastic and ceramics. It cannot penetrate liquid water or metal. The imaging area depth is typically less than 10 m. At a 5 m distance it is possible to take a submillimetre picture of a height of 2 m using a passive system.

6.11 Imaging use cases

6.11.1 General

A use case is a written description of how users can perform tasks on the imaging system. It outlines, from a user's point of view, a system's behaviour as it responds to a request.

A more detailed definition of use cases is required when configuring the imaging system for a specific environment and for specialized use.

6.11.2 Imaging system baseline use cases

[Tables 1](#) to [10](#) describe the baseline use cases.

Table 1 — Use case actors

Actor	Description
Subject	Subject for photography
Operator	Person who operates the imaging system
Technician	Person who maintains the imaging system

Table 2 — Use case 1: Give advice

Actor	Operator
Basic flow	Give advice to the subject on how to behave while photographed

Table 2 (continued)

Actor	Operator
Actor	Subject
Basic flow	Follow the instructions given by the operator

Table 3 — Use case 2: Input data

Actor	Operator
Basic flow	Input data describing the subject; ask the subject questions if needed
Actor	Subject
Basic flow	Answer questions asked by the operator

Table 4 — Use case 3: Take picture

Actor	Operator
Basic flow	Take a picture or shoot video of the subject with the imaging system
Actor	Subject
Basic flow	Pose for the camera

Table 5 — Use case 4: Save picture

Actor	Operator
Basic flow	Check the picture quality with the supplied software, make adjustments and calibrate the system if required to do so; save the picture or video and related data

Table 6 — Use case 5: Calibrate

Actor	Operator
Basic flow	Calibrate the system using imaging system adjustment and calibration software to conform to standard requirements
Actor	Technician
Basic flow	Calibrate the system using analysis software and make required hardware and software adjustments to conform to standard requirements

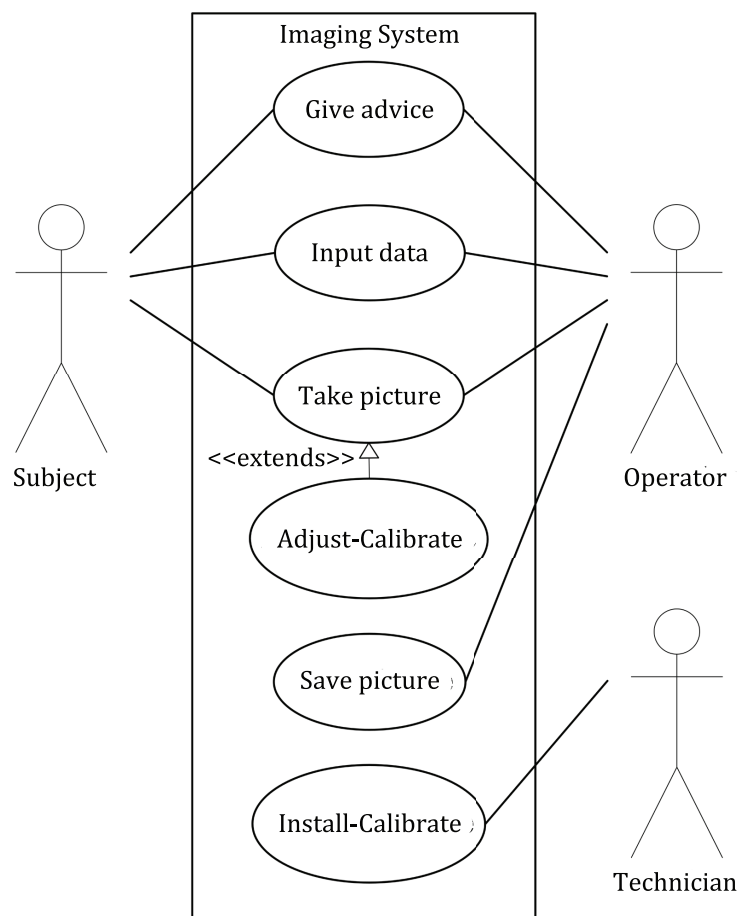
Table 7 — Use case 6: Install-calibrate

Actor	Technician
Basic Flow	Install, make adjustments and calibrate the system using software installation, analysis software and make required hardware and software adjustments to conform to standard requirements

"Install" involves placing of imaging equipment and other requisites in position and connecting and adjusting for use. It also includes the transfer of computer software from a distribution file to a permanent location on disk or other program storage media and preparing it for its particular environment and application [15].

Calibration involves adjustment of the imaging system so that it can be used in an accurate and exact way. Using measurement targets and measuring instruments the Technician is able to determine the deviation from a standard so as to ascertain the proper corrections. Using the imaging system for subject measurement requires calibration. Image calibration provides a pixel-to-real-distance conversion factor that allows image scaling to metric units. Accurate information on the height is obtained via photogrammetry, including the reference points in the photographed area, for example a standardized range pole.

Figure 12 illustrates the use cases described in Tables 1 to 10.



NOTE Taking a photograph can be interpreted also as taking a video clip.

Figure 12 — Imaging system use cases

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 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 biometric data block. 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, then 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, then 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 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*.

Most of the body image data record parameters are considered as optional to allow application specific profiles and efficient storage of the available data.

Data elements shall use ISO/IEC 39794-5 definitions if so advised in the element abstract value definition in this document.

7.1.2 Body tree concept

Tree structures are well suited to XML as the XML documents form a tree structure that starts at the root and branches to the leaves. ITU-T Rec. X.694 provides a mapping from XML Schema to ASN.1. The U.S. National Library of Medicine also designed four databases (Unified Medical Language System, UMLS) whose exchange formats are specified in ASN.1. The need to use a tree structure is application dependent and particularly useful in linked data systems.

MeSH (Medical Subject Headings) RDF is faithful to the MeSH XML data model that NLM (United States National Library of Medicine) has produced for a number of years. An underlying structure for full body elements is defined by the MeSH. MeSH descriptors form an organized way to describe different body parts. MeSH is the U.S. National Library of Medicine controlled vocabulary thesaurus. For example, ear is defined in a tree structure as A - Anatomy -> A01 - body regions -> A01.456 - head -> A01.456.313 - ear. This description method allows the use of unified representation blocks in linked data systems using well described links between resources. The main structure of an XML document is tree-like, and most of the lexical structure is devoted to defining that tree.

In [Figure 13](#) the full body root node is the "Body regions 01" named after the MeSH descriptor. Other child elements are either entity references or elements containing allowed element contents.

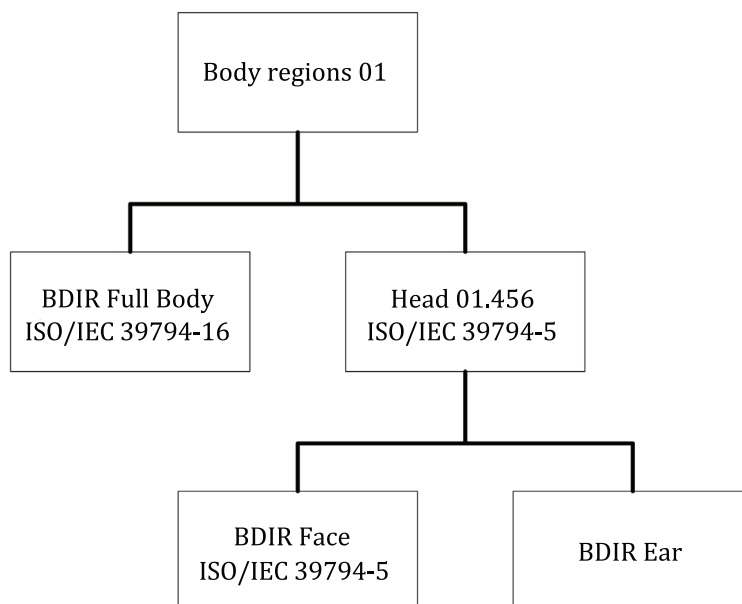


Figure 13 — Full body root node and child elements

Full body imaging systems produce 2D images or 3D models for human examination and for automated full body verification and identification. Instead of using representations as isolated entities, a more organized way is to utilize the body tree structure. In this context an image should be perceived as any descriptive data set describing a human body or part of the body.

A few well-established databases for identification of missing persons and unknown bodies have been deployed by the international and national police authorities. There are several widely used data models such as INTERPOL DVI for disaster victim identification ([Figure 14](#)) and VERMI-UTOT (VUTOT) of the German Federal Criminal Police. Such databases contain both biometric and non-biometric data.

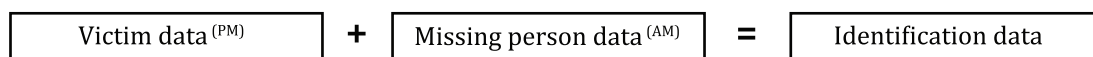


Figure 14 — INTERPOL DVI document structure

Machine learning applications are able to produce landmark points and biometric feature vectors constructed from a biometric data set. Feature vectors only remotely resemble conventional images. The use of a convolutional neural network (CNN) helps to reduce identification errors^[46]. Local processing using neural network is always possible using local feature vector or tensor formats. However, full body image output data or gait image sequence output data for information interchange using ASN.1 or XML shall follow the format specifications given in this document. For information interchange the image format shall conform to one of the encodings given in [6.2](#).

[Figure 15](#) illustrates a simplified diagram of a fully connected neural network. Three input nodes form the input layer, eight hidden nodes form two hidden layers of four neurons, and one node forms the regression output layer. More than one output layer is needed for classification.

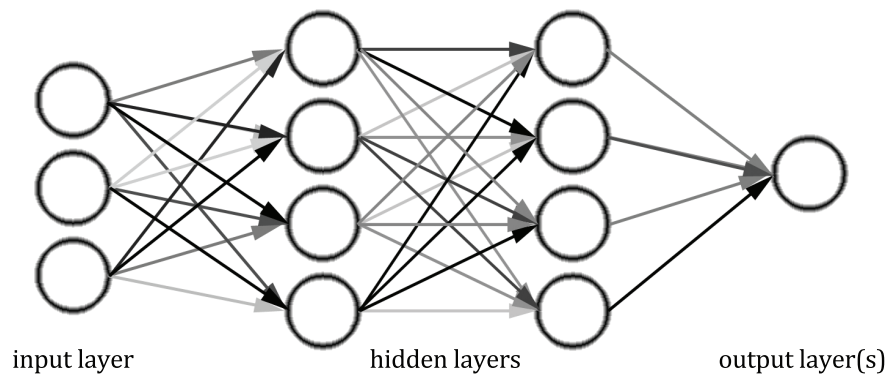


Figure 15 — Typical simplified neural network architectural diagram

The CNN in machine learning applications facilitate advances not only in full body image classification and modelling, but also in decomposing a human full body image into semantic body regions and clothes [46]. Advanced neural network architectures can recognize human faces or body features with any view in a certain viewing angle range, e.g. from left 30° to the right 30° of yaw angle rotation. To recognize targeted subject features of a specific view, the selected architecture can require the use of parallel view specific neural networks instead of a single neural network.

[Figure 16](#) illustrates the possibilities offered by full body images and videos, which provide a wide selection of biometric features for various processes.

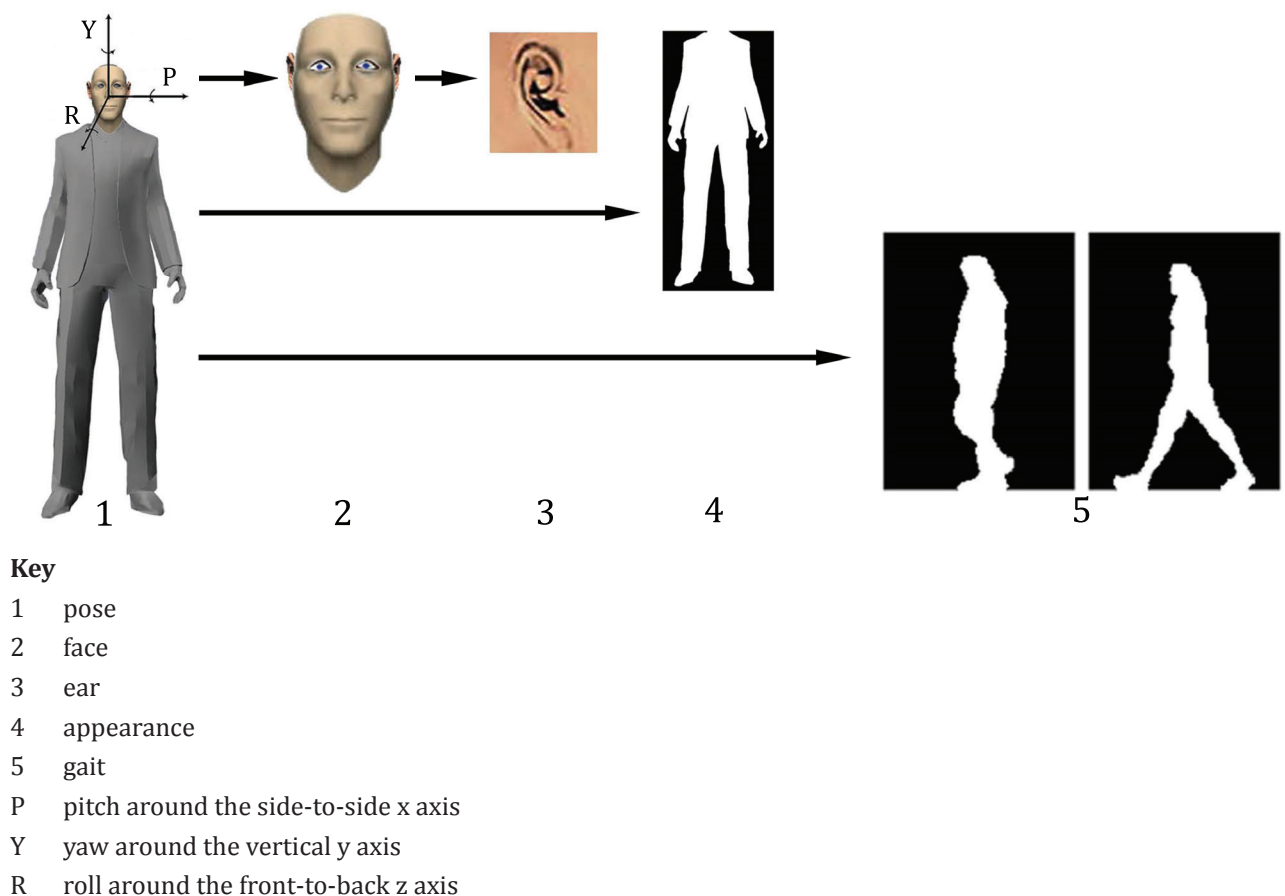


Figure 16 — Full body features for various processes

Standard poses, element structures and data formats help the parsing of the body tree data into body part representations. Parsing can be done using methods and algorithms which process the human body as an assembly of parts. Segmentation can be used as a pre-processing step.

7.1.3 Anthropometric data models

Anthropometry means, literally, the measurement of people.

Biometric or anthropometric applications can be roughly divided into three different categories:

- internal human body structure reconstruction;
- human body surface reconstruction;
- human body motion analysis.

Table 8 — Cross-reference table for different data models

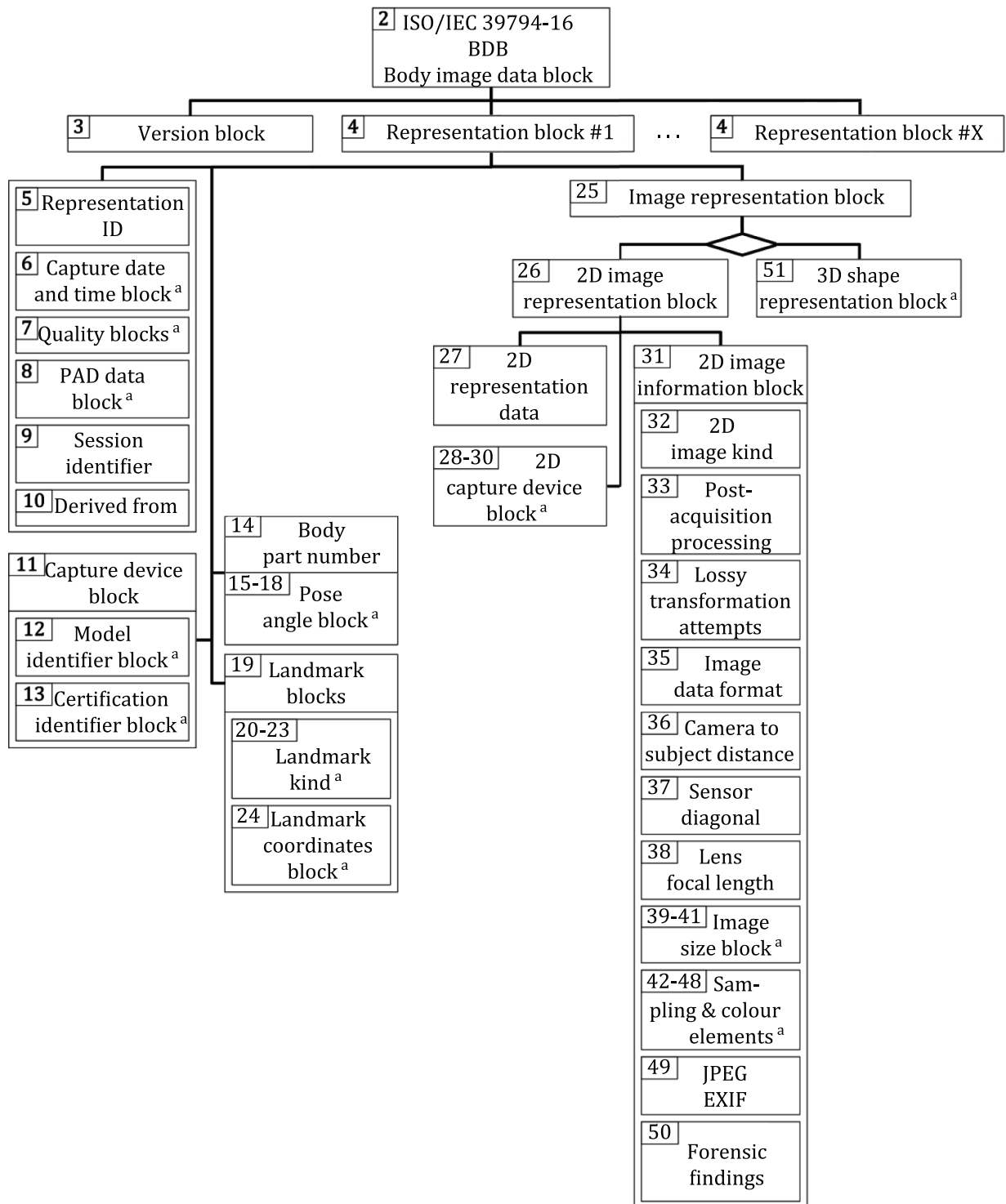
Model scope	Process scope	Model name
Internal human body structure reconstruction	body tree based standard selection, personal data reference	MeSH
Human body surface reconstruction	personal data reference	Anthropometric landmarks, CAESAR
Human body surface reconstruction	3D modelling landmarks	MPEG-4
Human body motion analysis	gait recognition landmarks	MPEG-4

Internal human body structure recovering based on MeSH allows 3D reconstruction of anatomical parts for biometric standards related process and application selection. Human body surface reconstruction modelling is required to describe landmark locations on the body.

The MPEG-4 face/body animation parameters (FAP/BAP) are used to animate face/body models. Human body motion recognition may also be achieved by analyzing the extracted 3D pose parameters. Smart surveillance systems, capable of more than single-motion detection, can take advantage of the 3D human motion analysis by incorporating specific knowledge about human shape and appearance, in order to decrease false alarms. High-level analysis is able to distinguish between simple authorized and non-authorized activities.

7.1.4 Structure overview

The order of the abstract data elements in [7.2](#) and beyond is derived from traversing the tree in [Figure 17](#) from left to right, depth first. A more formal description of the structure is given in [A.1](#) for ASN.1 and in [A.2](#) for the XML encoding of these abstract data elements.

**Key**^a

Elements which can be divided in sub-elements, not shown in this figure.



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



denotes that this element is defined in subclause 7.n

Figure 17 — ISO/IEC 39794-16 body image data block