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Information technology — Biometric data interchange formats —

Part 9: Vascular image data

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

Partie 9: Données d'images vasculaires

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 19794-9 was prepared by Technical Committee ISO/TC JTC1, *Information technology*, Subcommittee SC 37, *Biometrics*.

This second edition cancels and replaces the first edition (ISO/IEC 19794-9:2007), Clause 8 and Annex A of which have been technically revised.

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*

— *Part 7: Signature/sign time series data*

— *Part 8: Finger pattern skeletal data*

— *Part 9: Vascular image data*

— *Part 10: Hand geometry silhouette data*

— *Part 11: Signature/sign processed dynamic data*

— *Part 13: Voice Data*

— *Part 14: DNA data*

Introduction

Vascular biometric technologies have existed for many years. Additionally, new technologies employing vascular images obtained from various parts of the human body are emerging or under continuous improvement as a result of new, state-of-the-art imaging devices. Some of them are being widely adopted as reliable biometric modalities.

Currently however, little vascular biometric image information is being exchanged between the equipment and devices from different vendors. This is due in part to the lack of standardized formats for information exchange that would ensure interoperability among the various vendors.

The purpose of this part of ISO/IEC 19794 is to define a standard for the exchange of human vascular biometric image information. It defines specific attributes, a data record format for storing and transmitting vascular biometric images and certain attributes, a sample record, and conformance criteria.

This part of ISO/IEC 19794 is intended for applications requiring the exchange of raw or processed vascular biometric images. It is intended for applications not limited by the amount of storage required. It is a compromise or a trade-off between the resources required for data storage or transmission and the potential for improved data quality/accuracy. Basically, it is to enable various algorithms to identify or verify the vascular biometric image data transferred from other image sources. Currently available vascular biometric technologies that may utilize this part of ISO/IEC 19794 for image exchange are technologies that use the back of the hand, palm, and finger.

The use of captured source images can provide interoperability among and between vendors relying on various different recognition or verification algorithms. Accordingly, data from the captured vascular biometric image offers the developer more freedom in choosing or combining a comparison subsystem.

Information technology — Biometric data interchange formats —

Part 9: Vascular image data

1 Scope

This part of ISO/IEC 19794 specifies an image interchange format for biometric person identification or verification technologies that utilize human vascular biometric images and may be used for the exchange and comparison of vascular image data.

It specifies a data record interchange format for storing, recording, and transmitting vascular biometric information from one or more areas of the human body. It defines the contents, format, and units of measurement for the image exchange. The format consists of mandatory and optional items, including scanning parameters, compressed or uncompressed image specifications and vendor-specific information.

Information compiled and formatted in accordance with this part of ISO/IEC 19794 can be recorded on machine-readable media or may be transmitted by data communication facilities.

2 Conformance

A biometric data record conforms to this part of ISO/IEC 19794 if it satisfies all of the normative requirements related to:

a) its data structure, data values, and the relationships between its data elements, as specified throughout Clause 9 for the Vascular Image Record Format of this part of ISO/IEC 19794, and

b) the relationship between its data values and the input biometric data from which the biometric data record was generated, as specified throughout Clause 9 for the Vascular Image Record Format of this part of ISO/IEC 19794.

A system that produces biometric data records is conformant to this part of ISO/IEC 19794 if all biometric data records that it outputs conform to this part of ISO/IEC 19794 (as defined above), as claimed in the Implementation Conformance Statement associated with that system. A system does not need to be capable of producing biometric data records that cover all possible aspects of this part of ISO/IEC 19794, but only those that are claimed to be supported by the system in the Implementation Conformance Statement (ICS).

A system that uses biometric data records is conformant to this part of ISO/IEC 19794 if it can read, and use for the purpose intended by that system, all biometric data records that conform to this part of ISO/IEC 19794 (as defined above), as claimed in the Implementation Conformance Statement associated with that system. A system does not need to be capable of using biometric data records that cover all possible aspects of this part of ISO/IEC 19794, but only those that are claimed to be supported by the system in an ICS.

3 Normative reference

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 10918-1, *Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines*

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

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

ISO/IEC 19794-1:2011, *Information technology — Biometric data interchange formats — Part 1: Framework*

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
centroid
centre of gravity

NOTE In this part of ISO/IEC 19794, it is used to define a unique location within a silhouette image that can be assumed as the origin of a coordinate system.

4.2
dorsal
back side of a finger or a hand

4.3
vascular biometric image
captured raw or processed image that represents physical characteristics or traits of vascular pattern used to recognize the identity or verify the claimed identity of an individual

4.4
vascular image header record
information contained in the header data structure of the vascular image data format as specified in this part of ISO/IEC 19794

4.5
ventral
palm side of a finger or a hand

5 Abbreviated terms

nm nanometre

ppcm pixels per centimetre

VIR vascular biometric image record

RGB red, green, blue color model

6 Data conventions

6.1 Byte and bit ordering

The quantities in all records and vascular biometric image elements (pixel data), if represented as multibyte quantities, are represented in big-endian format. That is, the more significant bytes of any multibyte quantity are stored at lower addresses in memory than are the less significant bytes. The order for transmission shall also be the most significant byte first and the least significant byte last. Within a byte, the order of transmission shall be the most significant bit first and the least significant bit last. All numeric values are unsigned integer quantities of fixed-length.

6.2 Scan sequence

A raw vascular image data conforming to this part of ISO/IEC 19794 is a two dimensional bit-mapped data that scans an object from the upper left corner to the lower right corner within a region of interest of a human body. This standard defines the scan direction of an imaging sensor as being along the positive x and y-axis which is defined in clause 7.9 for each vascular biometric technology, assuming the target human body (finger, back of the hand, or palm, etc.) is positioned in standard pose. The standard pose is defined in clause 7.8. If an image is scanned in a standard pose, the x and y-axis of the object coordinate system is in parallel with the x and y-axis of the image coordinate system. The x-direction of the image coordinate system is defined as the scan line from left to right and the y-direction as being from the top to the bottom of the image. Additionally, in a standard pose, the object z-axis is assumed to be in a direction parallel with the z-axis of the imaging device.

The scan sequence shall be raster scan order; that is, image pixels are acquired along the x-axis from top to bottom in the y-direction. In order to map the object coordinate system to the image coordinate system without further translation, each vascular biometric image data may define the x and y-axis origin which is not the pixel location of the upper-left corner of the image. If the origin is not specifically defined, it shall be the pixel location of the upper-left corner of the image.

7 Image capture requirements

7.1 Spatial sampling rate

Image capture requirements are dependent on various factors such as the type of application, the available amount of raw pixel information to be retained or exchanged, and the targeted performance. Another factor to consider as a requirement for vascular biometric imaging is that the physical size of the target body area where an application captures an image for the extraction of vascular pattern data varies substantially (unlike other biometric modalities). For example, a finger vein biometric device may require higher spatial sampling rate than a palm vein device due to difference size of the observed biometric characteristic. Therefore, this standard does not specify the requirement of minimum spatial sampling rate. However, the spatial sampling rate of the captured image shall be represented in terms of pixels per centimetre.

7.2 Bit-depth

The image shall have a dynamic range spanning at least 128 gray scale levels, allocating at least one byte (8 bits) per intensity value and providing at least 7 bits of useful intensity information. The image may utilize two or more bytes per gray scale value instead of one.

7.3 Illumination

For the capture of vascular biometric images, the skin is typically illuminated using near-infrared wavelengths in the range of approximately 700 to 1200 nm. The angle from the light source to the tangent plane of the skin's surface is not defined in VIR because technologies that use a reflectance image may use diffuse illumination instead of direct illumination for the purpose of avoiding specular reflectance. Instead, this standard specifies that the image is either based on transparency or reflectance of the observed biometric

characteristic. Two or more wavelengths of illumination light source may be specified in the case that multiple different light sources are used for background masking.

7.4 Pixel aspect ratio

The default pixel aspect ratio is 1:1. If the image is not of square pixels, the aspect ratio shall be described.

7.5 Normalization of projection

The captured image shall be an orthographic projection of the body area being imaged. If the original raw image is not orthographic to the body area, it shall be converted to an orthographically projected one. Any major geometric distortion caused by the optical system shall also be eliminated prior to creation of the VIR.

7.6 Image storage format

The captured vascular image shall be transmitted and stored in one of several possible formats described in the following paragraphs.

7.6.1 Raw format

The image is represented by a rectangular array of pixels with specified numbers of columns and rows. Each pixel has at least 8 bits of information. There is no image header, and each pixel in a monochrome image is represented by one or more bytes. Color images are represented as three samples per pixel, each comprised of one or more bytes, representing red, green, and blue (RGB) intensities, in that order. The image is organized in row-major order, with the lowest address corresponding to the upper left corner of the image. If the pixel intensity value is represented by more than one byte, the bytes shall be stored in big-endian order.

7.6.2 Lossless compression format

If lossless compression is used the image data shall be compressed in accordance with the JPEG-LS lossless compression algorithm specified in ISO/IEC 14495-1 or the JPEG2000 compression algorithm specified in ISO/IEC 15444-1.

7.6.3 Lossy compression format

If lossy compression is used the image shall be compressed in accordance with the JPEG compression algorithm specified in ISO/IEC 10918-1 or the JPEG2000 compression algorithm specified in ISO/IEC 15444-1. If one of these compression algorithms is used, a compression factor of 4:1 or less is recommended.

7.6.4 Multichannel image format

Images may be acquired utilizing more than three colors or channels utilizing multichannel cameras. In this case, pixel values may not be directly related to specific colors, rather they may be related to certain physical characteristics. Images captured with more than three sensing channels shall be stored in accordance with the JPEG2000 compression algorithm as specified in ISO/IEC 15444-1.

7.7 Imaging area

Vascular pattern biometric technologies obtain images from different locations of the human body. The technologies currently available employ images from the finger, back of the hand, and palm side of the hand. The location used for imaging shall be specified in the format. Also, the direction (left/right) of hand and/or finger index (thumb, index, middle, ring, and little) shall be specified. This part of ISO/IEC 19794 reserves fields for future development of technologies that may utilize different parts of human body.

7.8 Standard pose

This part of ISO/IEC 19794 defines the standard poses to capture raw images of target body areas. Based on these standard poses, object (target area of the human body) coordinate systems are defined as described in clause 7.9.

7.8.1 Back of the hand

The standard pose for the back of the hand shall be to position the hand with the dorsal side toward the capture device with the tangent plane of the back of the hand in parallel with the image coordinate space to produce an orthographic image of the back of the hand. An example of the standard pose of the back of the hand is shown in Figure 1. In the standard pose, the camera's direction is parallel to the z-axis of the back of the hand coordinate system defined in clause 7.9.1.

7.8.2 Palm

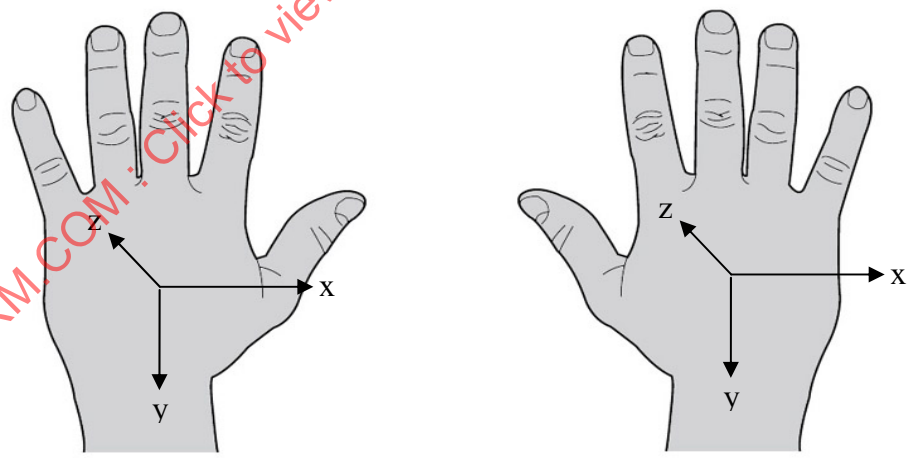
The palm area shall not be bent and each finger boundary shall be exposed to the camera. Fingers shall be straight. An example of the standard pose of a palm is shown in Figure 2. In the standard pose, the camera's direction is parallel to the z-axis of the palm coordinate system defined in clause 7.9.2.

7.8.3 Finger

The standard pose is a straight finger. For clarity, the "frontal side" is defined as the ventral side of each finger. An example of the standard pose of a finger is shown in Figure 3.

7.8.4 Standard poses for future modalities

The format shall reserve standard pose definitions of future technologies that may utilize different part of the human body.



Left hand Right hand

Figure 1 — Standard pose and object coordinate system of the back of the hand vascular biometrics. The Euclidean direction is right-handed.

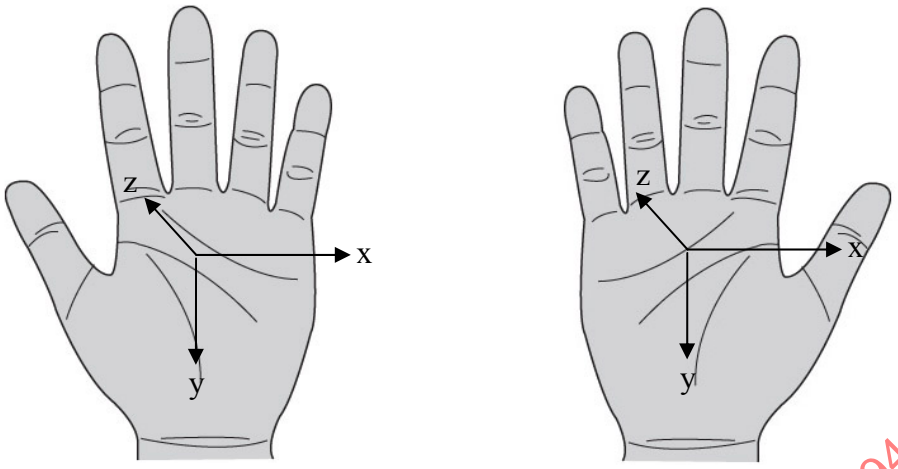
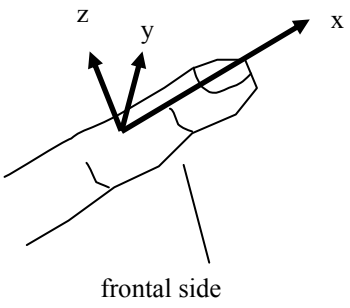


Figure 2 — Standard pose and object coordinate system of palm vascular biometrics. The Euclidean direction is right-handed.



z-axis: (minus) normal to the frontal side

x-axis: the direction from root to tip

Figure 3 — Standard pose and object coordinate system of finger vascular biometrics. The Euclidean direction is right-handed.

7.9 Object coordinate system

The vascular image header record provides an optional field that specifies the degree of rotation of the vascular image out of the standard pose. To effectively specify the rotation angle, the object (target body) coordinate system for each vascular technology is defined in this clause. All of the coordinate systems are right-handed Euclidian coordinate systems.

7.9.1 Back of the hand

The y-axis of a back of the hand object is along the opposite direction of the middle finger, while the x-axis is perpendicular to the y-direction along the tangent plane on the back of the hand as shown in Figure 1. The z-axis shall be orthogonal to both the x-axis and the y-axis. The positive z-axis direction is away from the imaging device, which follows the right-handed Euclidean coordinate system. The origin of the object coordinate system is defined as the centroid of the hand silhouette image.

7.9.2 Palm

The y-axis of a palm object is along the opposite direction of the middle finger, while the x-axis is perpendicular to the y-direction on the palm plane as shown in Figure 2. The z-axis shall be determined by the right-handed Euclidean coordinate system; thus the positive direction of z-axis is away from the imaging device. The origin of the object's coordinate system is defined as the centroid of hand silhouette image.

7.9.3 Finger

The x-axis is defined as the direction from the root to the tip of a finger as shown in Figure 3. The z-axis is the direction perpendicular to the x-axis and away from the frontal side. The y-axis is perpendicular both to the x and the z-axes with the direction following the right-handed Euclidean coordinate system. The origin of the finger coordinate system is defined as the centroid of the finger silhouette image.

7.9.4 Coordinate systems for future modalities

The format shall reserve object coordinate system definitions for future technologies that may utilize different parts of the human body.

7.10 Occlusion by opaque artifacts

Some opaque artifacts, such as rings, tattoos, bandages, etc. may occlude vascular patterns. Using images including occlusions should be avoided.

8 Vascular image format specification

8.1 Biometric Data Record

Table 1 shows the basic structure of the vascular image biometric data record. A single data block starts with a General Header, which contains general information on the data block such as the identification of the image capture device and the format version. One or more vascular image blocks follow the record header. Each image block consists of an image header and raw or compressed image data. The image header contains all the image specific information such as the body location, rotation angle, and imaging conditions. Each image header data shall be stored in big-endian format, where bit-level data definitions are specified as: bit 1 shall be interpreted as the least significant bit (LSB).

Table 1 — Biometric Data Record

Description		Length	Note
General Header		15 bytes	Header used by all vascular biometric image providers. Information on format version, capture device ID, number of representations contained in the VIR, etc.
Representation	Representation header	40 bytes + 5*(#QualityBlocks)	Representation header for the first representation. Contains all individual image specific information
	Image data	{Representation length} – size of Representation header	Representation body
	Extended data	{ Extended Data Block Length } + 4	Extended data block
	• • •		• • •
Representation	Representation header	40 bytes + 5*(#QualityBlocks)	Representation header for the last representation
	Image data	{Representation length} – size of Representation header	Representation body
	Extended data	{ Extended Data Block Length } + 4	Extended data block

8.2 General Header

The General Header defines general information on the vascular images contained in the data block, such as the format version number, total length of the record block, capture device identification, and the number of images contained in the data block. The record header format is shown in Table 2.

Table 2 — General Header

Description	Length	Valid value	Note
Format Identifier	4 bytes	56495200_{Hex}	'V' 'I' 'R' 00_{Hex} (Vascular Image Record)
Version number	4 bytes	30323000_{Hex} ('0' '2' '0' 00_{Hex})	This number indicates the second version of this part of ISO/IEC 19794 used for constructing the iris image data record and shall be placed in four bytes. This version number shall consist of three ASCII numerals by a zero byte as a NULL string terminator
Length of record	4 bytes	00000000_{Hex} to $FFFFFFFF_{Hex}$	Total length of data record in bytes
Number of representations	2 bytes	0000_{Hex} to $FFFF_{Hex}$	Number of images that a vascular image record block contains
Certification flag	1 byte	00_{Hex}	This field indicates if each representation has a certification block (zero or more certifications). 00_{Hex} no certification available

8.2.1 Format identifier

The format identifier shall be recorded in four bytes. The format identifier shall consist of three characters "VIR" followed by a zero byte as a NULL string terminator.

8.2.2 Version number

The number for the version of that part of ISO/IEC 19794 used for constructing the BDIR shall be placed in four bytes. This version number shall consist of three ASCII numerals followed by a zero byte as a NULL string terminator. The first and second character will represent the major version number and the third character will represent the minor revision number. Upon approval of a specification, the initial version number will be “020” – Version 2 revision 0.

8.2.3 Length of record

The length (in bytes) of the entire BDIR shall be recorded in four bytes. This count shall be the total length of the BDIR including the general record header and one or more representation records.

8.2.4 Number of Representations

The total number of representation records contained in the BDIR shall be recorded in two bytes. A minimum of one representation is required.

8.2.5 Certification flag

The one-byte certification flag shall indicate whether each Representation Header includes a certification block. A value of 00_{Hex} shall indicate that no representation contains a certification block. A value of 01_{Hex} shall indicate that all representations contain a certification block. As this part of ISO/IEC 19794 does not support certifications this field shall be 00 Hex.

8.3 Representation header

8.3.1 Overview

Each image contained in the Biometric Data Record is associated with a Representation header describing individual image-specific information. The header structure is summarized in Table 3.

Table 3 — Representation header

Description		Length	Valid Value	Note
Representation length		4 bytes	00000000_{Hex} to $FFFFFFFF_{Hex}$	The representation-length field denotes the length in bytes of the representation including the representation header fields.
Capture date and time Calendar year Month Day Hour Minute Second Millisecond		 2 bytes 1 byte 1 byte 1 byte 1 byte 1 byte 2 bytes	 1 to 65534 1 to 12 1 to 31 1 to 23 1 to 59 1 to 59 0 to 999, $FFFF_{Hex}$	The capture date and time in Coordinated Universal Time (UTC). Its value shall be encoded in the form given in ISO/IEC 19794-1.
Capture device technology ID		1 bytes	00_{Hex} to FF_{Hex}	Technology type used by capture device. A value of 0 indicates “unknown or unspecified”. CAPTURE_DEVICE_TECHNOLOGY_UNDEF = 0 (00_{Hex})
Capture device vendor ID		2 bytes	0000_{Hex} to $FFFF_{Hex}$	ID of the biometric organization that owns the product that created the biometric record. It shall be registered with the IBIA or other approved registration authority. A value of all zeros shall indicate that the capture device vendor is unreported. CAPTURE_DEVICE_VENDOR_UNDEF = 0(0000_{Hex})
Capture device type ID		2 bytes	0000_{Hex} to $FFFF_{Hex}$	The product type that created the BDIR. A value of all zeros shall indicate that the capture device type is unreported. CAPTURE_DEVICE_TYPE_UNDEF = 0(0000_{Hex})
Number of quality blocks		1 byte	0 to 255	This field is followed by the number of 5-byte Quality Blocks reflected by its value. A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present.
Quality Block	Quarity score	1 byte	0 to 100, 255	Quality Score is a quantitative expression of the predicted comparison performance of the vascular image data. 0: lowest 100: highest 255: failed attempt to assign a quality score
	quality algorithm vendor identifier	2 bytes	0000_{Hex} to $FFFF_{Hex}$	ID registered by IBIA or other approved registration authority as a CBEFF biometric organization.
	a quality algorithm identifier	2 bytes	0000_{Hex} to $FFFF_{Hex}$	ID optionally registered with IBIA or other approved registration authority as a CBEFF Product Code.

Image type	2 bytes	0 to 4	TYPE_UNDEF = 0 (00_{Hex}) TYPE _HAND_BACK = 1 (01_{Hex}) TYPE _PALM = 2 (02_{Hex}) TYPE _FINGER_BACK = 3 (03_{Hex}) TYPE_FINGER_FRONT = 4 (04_{Hex})
Image width	2 byes	0000_{Hex} to $FFFF_{Hex}$	Raw image width in pixels.
Image height	2 bytes	0000_{Hex} to $FFFF_{Hex}$	Raw image height in pixels.
Bit-depth	1 bytes	7 to 16	Bit-depth per pixel; bits per color.
Image position and property bit field	2 bytes	Bit 1 to 2: 0 to 2 Bit 3 to 5: 0 to 5 Bit 6 to 7: 0 to 2 Bit 8 to 10: 0 to 4	Bit 1 to 2: Hand HAND_UNDEF = 0 HAND_RIGHT = 1 HAND_LEFT = 2 Bit 3 to 5: Finger index F_UNDEF = 0 F_THUMB = 1 F_INDEX = 2 F_MIDDLE = 3 F_RING = 4 F_LITTLE = 5 Bit 6 to 7: Imaging method IMAGING_UNDEF = 0 IMAGING_TRANSPARENCY = 1 IMAGING_REFLECTANCE = 2 Bit 8 to 10: Image flip FLIP_UNDEF = 0 FLIP_NONE = 1 FLIP_HORIZONTAL = 2 FLIP_VERTICAL = 3 FLIP_VERTICAL_HORIZONTAL = 4
Rotation angle	2 bytes	0000_{Hex} to $FFFF_{Hex}$	Image rotation angle around the z-axis out of a standard pose. The unit is degree normalized to 16-bit unsigned integer, (unsigned short) round (65536*(angle%360)/360) Refer to clause 7.9
Image format and compression	2 bytes	0 to 9	Image type and compression format: IMAGE_COMP_UNDEF = 0 (00_{Hex}) IMAGE_MONO_RAW = 1 (0001_{Hex}) IMAGE_RGB_RAW = 2 (0002_{Hex}) IMAGE_MONO_JPEG = 3 (0003_{Hex}) IMAGE_RGB_JPEG = 4 (0004_{Hex}) IMAGE_MONO_JPEG_LS = 5 (0005_{Hex}) IMAGE_RGB_JPEG_LS = 6 (0006_{Hex}) IMAGE_MONO_JPEG2000 = 7 (0007_{Hex}) IMAGE_RGB_JPEG2000 = 8 (0008_{Hex}) IMAGE_MULTI_JPEG2000 = 9 (0009_{Hex})

Illumination type	1 byte	0 to 7	The illumination type shall be one or a combination of the following: ILLUM_UNDEF = 0 (00_{Hex}) ILLUM_NIR = 1 (01_{Hex}) ILLUM_MIR = 2 (02_{Hex}) ILLUM_VISIBLE = 4 (04_{Hex}) If applicable, two or more illumination types may be specified by OR condition.
Image background definition	1 byte	0 to 1	The flag to indicate background definition. If the background is processed and set to monotone, this field shall be set to IMAGE_BACKGROUND_MONO; otherwise this field shall have the value. IMAGE_BACKGROUND_UNDEF = 0(00_{Hex}) IMAGE_BACKGROUND_MONO = 1(01_{Hex})
Horizontal scan resolution	2 bytes	0000_{Hex} to $FFFF_{Hex}$	Horizontal scan resolution in ppcm H_SCAN_RES_UNDEF= 0 (0000_{Hex})
Vertical scan resolution	2 bytes	0000_{Hex} to $FFFF_{Hex}$	Vertical scan resolution in ppcm V_SCAN_RES_UNDEF= 0 (0000_{Hex})
Pixel aspect ratio	2 bytes	0000_{Hex} to $FFFF_{Hex}$	Pixel aspect ratio. The first byte specifies y distance and the second byte x distance. For example, 0304_{Hex} means an aspect ratio of 3:4. If this field is undefined 0000_{Hex}, the default aspect ratio is assumed which is 1:1. ASPECT_RATIO_UNDEF = 0 (0000_{Hex})

8.3.2 Representation length

The representation-length field denotes the length in bytes of the representation including the representation header fields.

8.3.3 Capture date and time

The capture date and time field shall indicate when the capture of this representation started in Coordinated Universal Time (UTC). The capture date and time field shall consist of 9 bytes. Its value shall be encoded in the form given in ISO/IEC 19794-1.

8.3.4 Capture device technology ID

The capture device technology ID shall be encoded in one byte. This field shall indicate the class of capture device technology used to acquire the captured biometric sample. A value of 00_{Hex} indicates unknown or unspecified technology. See Table 4 for the list of possible values.

Table 4 — Capture device technology ID

Capture device technology ID	Class of device technology
0	Unknown or not specified
1	CCD/CMOS camera

8.3.5 Capture device vendor ID

The capture device vendor identifier shall identify the biometric organization that owns the product that created the BDIR. The capture device algorithm vendor identifier shall be encoded in two bytes carrying a CBEFF biometric organization identifier (registered by IBIA or other approved registration authority). A value of all zeros shall indicate that the capture device vendor is unreported.

8.3.6 Capture device type ID

The capture device type identifier shall identify the product type that created the BDIR. It shall be assigned by the registered product owner or other approved registration authority. A value of all zeros shall indicate that the capture device type is unreported. If the capture device vendor identifier is 0000_{Hex}, then also the capture device type identifier shall be 0000_{Hex}.

8.3.7 Quality block

8.3.7.1 Number of quality block

This field is followed by the number of 5-byte Quality Blocks reflected by its value. A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present.

8.3.7.2 Quality score

Quality score, as defined in ISO/IEC 29794-1, shall be a quantitative expression of the predicted verification performance of the biometric sample. Valid values for Quality Score are integers between 0 and 100, where higher values indicate better quality. A value of 255 is to handle a special case. An entry of 255 shall indicate a failed attempt to calculate a quality score. Multiple quality scores calculated by the same algorithm (same vendor ID and algorithm ID) shall not be present in a single representation.

8.3.7.3 Quality algorithm vendor ID

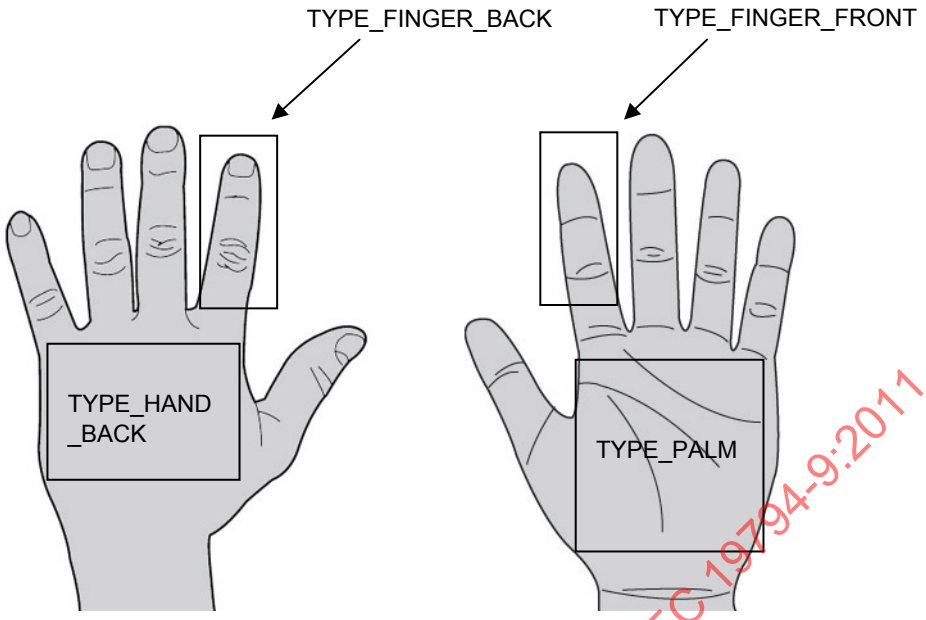
Quality Algorithm Vendor ID shall be registered with IBIA or other approved registration authority as a CBEFF biometric organization. Refer to CBEFF vendor ID registry procedures in ISO/IEC 19785-2. A value of all zeros shall indicate that the value for this field is unreported.

8.3.7.4 Quality algorithm ID

Quality Algorithm ID may be optionally registered with IBIA or other approved registration authority as a CBEFF Product Code. Refer to CBEFF product registry procedures in ISO/IEC 19785-2. A value of all zeros shall indicate that the value for this field is unreported.

8.3.8 Image type

This field specifies various body locations where vascular images have been captured. The following figure shows several examples of image location on the hands.



TYPE _HAND_BACK: The image is a scan of back of the hand.
TYPE _PALM: The image is a scan of palm.
TYPE_FINGER_FRONT: The image is a scan of finger from frontal side
TYPE_FINGER_BACK: The image is a scan of finger from back side

Figure 4 — Image type specification

8.3.9 Image width and height

These two fields specify the horizontal and vertical image size in pixels, in two bytes for each field.

8.3.10 Bit-depth

This field represents the number of bits per pixel in a gray scale image or the number of bits per color components per pixel in an RGB image.

8.3.11 Image position and property bit field

This field is a mandatory field specifying the position, direction, and properties of the object. The first two bits specify the direction of organ (toward the left or the right). If the image type is “finger”, then bits 3 through 5 specify which finger is captured among the thumb, index, middle, ring, or little finger. Bit 6 and 7 specifies whether the image has been captured by transparent or reflectance illumination. Bits 8 through 10 specify if the contained image is flipped or not, and if flipped how the image has been flipped.

8.3.12 Rotation angle

This field is optional, which may specify the rotation angle of the image around the z-axis in the object coordinate system. The unit is degree normalized to 16-bit signed integer as (unsigned short) round (65536*(angle%360) /360). Refer to clause 7.9.

8.3.13 Image format

This two-byte field specifies whether the image is monochrome or color components and how the image has been compressed if applicable. Currently allowed compression standards are JPEG, JPEG_LS, and JPEG2000.

8.3.14 Illumination type

This field is an informative optional field that specifies the capture device's illumination source. The defined types are near infrared (NIR), midrange infrared (MIR), and visible light source. The type of illumination shall be categorized based on the wavelength of illumination source; that is, the wavelength of visible illumination is in the range of 400 nm through 750 nm, the wavelength of NIR is in the range of 750 nm through 5,000 nm, and the wavelength of MIR is in the range of 5,000 nm through 25,000 nm.

8.3.15 Image background

This field specifies whether the background of the image has been processed or not. If the background has been processed and set to monotone, then this field shall have the value IMAGE_BACKGROUND_MONO (01_{Hex}); otherwise this field shall have the value IMAGE_BACKGROUND_UNDEF (00_{Hex}). Other valid values may be defined in future versions of this standard.

8.3.16 Horizontal scan resolution

This field specifies the scan resolution in the horizontal direction in ppcm. If the horizontal scan resolution is not specified, this field shall contain the value H_SCAN_RES_UNDEF= 0 (0000_{Hex}).

8.3.17 Vertical scan resolution

This field specifies the scan resolution in the vertical direction in ppcm. If the vertical scan resolution is not specified, this field shall contain the value V_SCAN_RES_UNDEF= 0 (0000_{Hex}).

8.3.18 Pixel aspect ratio

This two-byte field specifies the pixel aspect ratio. The first byte specifies y distance and the second byte x distance. For example, 0304_{Hex} means an aspect ratio of 3:4. If this field is undefined (0000_{Hex}), the default aspect ratio is assumed which is 1:1.

8.3.19 Vascular image header constants

The significance of specific constants within the header structures are as follows:

Table 5 — Image header constant definitions

Constant	Description
UNDEF	Usage in any constant indicates that the parameter is undefined.
TYPE_HAND_BACK	The location of the captured image is the back of a hand.
TYPE_PALM	The location of the captured image is palm.
TYPE_FINGER_BACK	The location of the captured image is the dorsal side of a finger.
TYPE_FINGER_FRONT	The location of the captured image is the frontal side of a finger.
HAND_RIGHT	The right hand is scanned. Applicable for finger, palm, and back of the hand scans.
HAND_LEFT	The left hand is scanned. Applicable for finger, palm, and back of the hand scans.
F_THUMB F_INDEX F_MIDDLE F_RING F_LITTLE	Identifies the scanned finger.

IMAGING_TRANSPARENCY	The type of imaging method is transparency imaging.
IMAGING_REFLECTANCE	The type of imaging method is reflectance imaging.
FLIP_NONE	Horizontal or vertical orientation is not changed from the one imaged from standard pose.
FLIP_HORIZONTAL	Horizontal orientation is opposite from the one imaged from standard pose.
FLIP_VERTICAL	Vertical orientation is opposite from the one imaged from standard pose.
FLIP_VERTICAL_HORIZONTAL	Horizontal and vertical orientation is opposite from the one imaged from standard pose.
IMAGE_MONO_RAW	The image is in raw format, with the width and height in pixels specified by the raw image width and height, respectively. This format has no header. Each pixel is one intensity value and the lowest address corresponds to the upper left corner of the image, in row-major order.
IMAGE_RGB_RAW	The image is in raw format, with the width and height in pixels specified by the raw image width and height, respectively. This format has no header. Each pixel is at least three consecutive bytes, representing values of red, green, and blue intensity. The lowest address corresponds to the upper left corner of the image, row-major order.
IMAGE_MONO_JPEG	The image is monochrome and compressed using the JPEG algorithm as specified in ISO/IEC 10918.
IMAGE_RGB_JPEG	The image is color and compressed using the JPEG algorithm as specified in ISO/IEC 10918.
IMAGE_MONO_JPEG_LS	The image is monochrome and compressed using the JPEG-LS algorithm as specified in ISO/IEC 14495.
IMAGE_RGB_JPEG_LS	The image is color and compressed using the PEG-LS lossless compression algorithm as specified in ISO/IEC 14495.
IMAGE_MONO_JPEG2000	The image is monochrome and compressed using the JPEG2000 algorithm as specified in ISO/IEC 15444.
IMAGE_RGB_JPEG2000	The image is color and compressed using the JPEG2000 algorithm as specified in ISO/IEC 15444.
IMAGE_MULTI_JPEG2000	The image has more than three channels (multi-channel) and compressed using the JPEG2000 algorithm as specified in ISO/IEC 15444.
ILLUM_NIR	The image is captured utilizing near infrared illumination. The wavelength range of near infrared illumination is defined as 700 nm through 5,000 nm.
ILLUM_MIR	The image is captured utilizing midrange infrared illumination. The wavelength range of midrange infrared illumination is defined as 5,000 nm through 25,000 nm.
ILLUM_VISIBLE	The image is captured utilizing visible range illumination.
IMAGE_BACKGROUND_MONO	The background of the image has been processed and set to monotone.

8.4 Extended data

8.4.1 Extended data Block Function

This clause of the vascular representation is open to placing additional data that may be used by the comparison system. The size of this section shall be kept as small as possible, augmenting the image data stored in the standard image data section. The extended data for each vascular representation shall immediately follow the standard image data for that vascular representation and shall begin with the Extended

Data Block Length field. More than one extended data area may be present for each vascular representation. The individual extended data length fields are used as indices to parse the extended data.

NOTE The extended data area cannot be used alone, without the standard portion of the Image record.

While the extended data area allows for inclusion of proprietary data within the image format, this is not intended to allow for alternate representations of data that can be represented in open manner as defined in this part of ISO/IEC 19794. The intention of this part of ISO/IEC 19794 is to provide interoperability.

Table 6 — Extended Data Structure

Field		Size	Notes
Extended Data Block Length		4 bytes	Segmentation, annotation, comment, or vendor data. Values >0100_{Hex} are vendor defined extended data
Extended data Block	Type Identification Code	2 bytes	
	Length data	4 bytes	
	Data section	Length data bytes	

8.4.2 Extended data Block Structure

8.4.2.1 Extended Data Block Length

All vascular records shall contain the extended data block length. This field will signify the existence of extended data. A value of all zeros will indicate that there is no extended data and that the file will end or continue with the next vascular representation. A nonzero value will indicate the length of all extended data starting with the next byte. The block length will then be followed by the type identification code (8.4.2.2), length of data field (8.4.2.3) and the data section (8.4.2.4).

8.4.2.2 Type Identification Code

This field shall have a length of two bytes. It shall identify the format of the extended data area when this area is present. A value of zero in both bytes is a reserved value and shall not be used. A value of zero in the first byte, followed by a non-zero value in the second byte, shall indicate that the extended data section has a format defined in this part of ISO/IEC 19794; currently, only segmentation, annotation, and comment formats are specified (refer to clauses 0, 8.4.4, and 8.4.5). A non-zero value in the first byte shall indicate a vendor-specified format with a code maintained by the vendor. Refer to Table 7 for a summary of the Extended Data Area Type Identification Codes.

Table 7 — Extended Data Area Type Codes

First byte	Second byte	Description
00_{Hex}	00_{Hex}	Reserved SC37 – do not use
00_{Hex}	01_{Hex}	Segmentation
00_{Hex}	02_{Hex}	Annotation
00_{Hex}	03_{Hex}	Comment
00_{Hex}	04_{Hex} to FF_{Hex}	Reserved SC37
01_{Hex} to FF_{Hex}	00_{Hex} to FF_{Hex}	Vendor defined extended data