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Information technology — Biometric data interchange format —

Part 15: Palm crease image data

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

Partie 15: Données relatives à l'image des lignes de la main

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO/IEC 19794 series can be found on the ISO website.

Introduction

Palm crease biometric technologies have existed for many years. Additionally, new technologies employing palm crease images obtained from hands are emerging or under continuous improvement as a result of new, state-of-the-art imaging devices for mobile applications or web services.

Currently however, palm crease biometric image information is being exchanged between the equipment and devices from different vendors without standardized format is the problem. 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 document is to define a standard for the exchange of human palm crease biometric image information. The standard defines specific attributes, a data record format for storing and transmitting palm crease biometric images and certain attributes, a sample record, and conformance criteria.

This document is intended for applications requiring the exchange of raw or processed palm crease biometric images. It is intended for applications not limited by the amount of storage required. It is a compromise or a trade-off between storage and quality and can be resolved by standardized format. It enables various algorithms to identify or verify the palm crease biometric image data transferred from other image sources. Currently, available palm crease biometric technologies that may utilize this document for image exchange are technologies that use palm for mobile applications for identify verification or web services.

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 palm crease biometric image offers the developer more freedom in choosing or combining a comparison subsystem

In this document, Annex A contains the conformance testing methodology and Annex B contains the XML schema. Annex C contains the XML sample program.

Information technology — Biometric data interchange format —

Part 15: Palm crease image data

1 Scope

This document specifies an image interchange format for biometric person identification or verification technologies that utilize human palm crease biometric images and can be used for the exchange and comparison of palm crease image data. It specifies a data record interchange format for storing, recording, and transmitting palm crease biometric information from palm crease imaging. 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 document can be recorded on machine-readable media or may be transmitted by data communication facilities.

2 Normative reference

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 10918 (all parts), *Information technology — Digital compression and coding of continuous-tone still images: JPEG File Interchange Format (JFIF)*

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

ISO/IEC 14495 (all parts), *Information technology — Lossless and near-lossless compression of continuous-tone still images: Extensions*

ISO/IEC 19785-1, *Information technology — Common Biometric Exchange Formats Framework — Part 1: Data element specification*

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

ISO/IEC 19794-1:2011/Amd 1:2013, *Conformance testing methodology*

ISO/IEC 19794-1:2011/Amd 2:2015, *Framework for XML encoding*

XML Schema Definition, W3C Recommendation, 2 May 2001[1)]

3 Terms and definitions

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

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

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

1) http://www.w3.org/XML/Schema

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

3.1
palm crease biometric image
captured raw or processed image that represents physical characteristics or traits of palm crease pattern used to recognize the identity or verify the claimed identity of an individual

4 Abbreviated terms

RGB	Red, green, blue color model
XML	eXtensible Markup Language
CBEFF	Common Biometric Exchange Formats Framework
BDIR	Biometric Data Interchange Record
BDB	Biometric Data Block
BIR	Biometric Information Record
ppcm	pixels per centimetre
ppi	pixels per inch

5 Conformance

A biometric data record conforms to this document 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 8 for the palm crease image record format of this document;

b) the relationship between its data values and the input biometric data from which the biometric data record was generated, as specified throughout Clause 8 for the palm crease image record format of this document.

A system that produces biometric data records is conformant to this document if all biometric data records that it outputs conform to this document (as defined 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 document, 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 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 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 document, but only those that are claimed to be supported by the system in an implementation conformance statement (ICS).

6 Data conventions

6.1 General

The format specified in this document is a structural definition used to exchange palm crease image data. In conformance with the rules described in ISO/IEC 19794-1, a palm crease image data should be specified upon the definition of the BDIR or may be wrapped in the biometric data block (BDB) of a CBEFF compliant structure (BIR) which is specified in ISO/IEC 19785-1.

6.2 Scan sequence

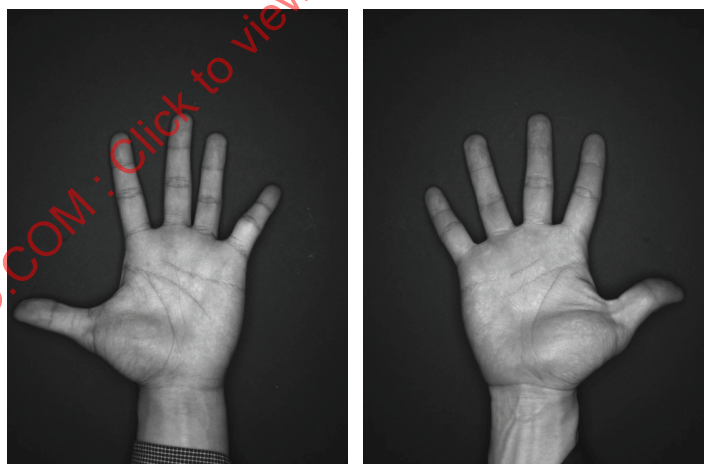
A raw palm crease image data conforming to this document is a two dimensional bit-mapped data that scans an object from the upper-left corner to the lower-right corner within a region of interest of a palm crease. This document defines the scan direction of an imaging sensor as being along the positive x-axis and y-axis for each palm crease biometric technology, assuming the target human body is positioned in standard pose. The standard pose is defined in 7.6. If an image is scanned in a standard pose, the x-axis and y-axis of the object coordinate system is in parallel with the x-axis 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. The z-axis of the object coordinate system is not considered in this document because the palm crease is detected only in 2D space. Normalization process is necessary to search the features.

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 palm crease biometric image data may define the x-axis 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.

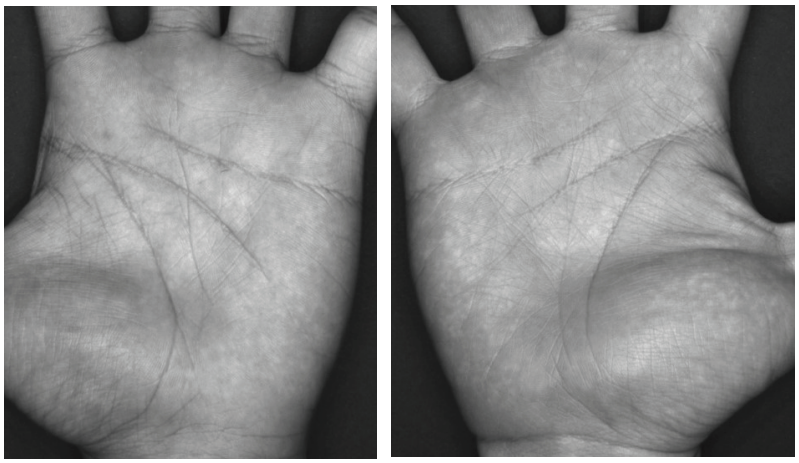
7 Image capture requirements

7.1 Spatial sampling rate

Image capture requirements are dependent on factors such as the type of application, raw pixel information, expected performance, and the physical size of the area to be captured for palm crease extraction. This standard specifies a minimum spatial sampling rate of 40 pixels per centimetre (ppcm). This value is the same as 100 pixel per inch (ppi). Figure 1 demonstrates two possible scanning areas: whole hand and partial hand with curvature points.



a) Whole hand



b) Partial hand with curvature points

Figure 1 — Scanning area of human hand

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 palm crease biometric images, the skin is typically illuminated using natural light or any means of lighting to support the capture of palm crease. The angle from the light source to the tangent plane of the skin's surface is not defined.

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.

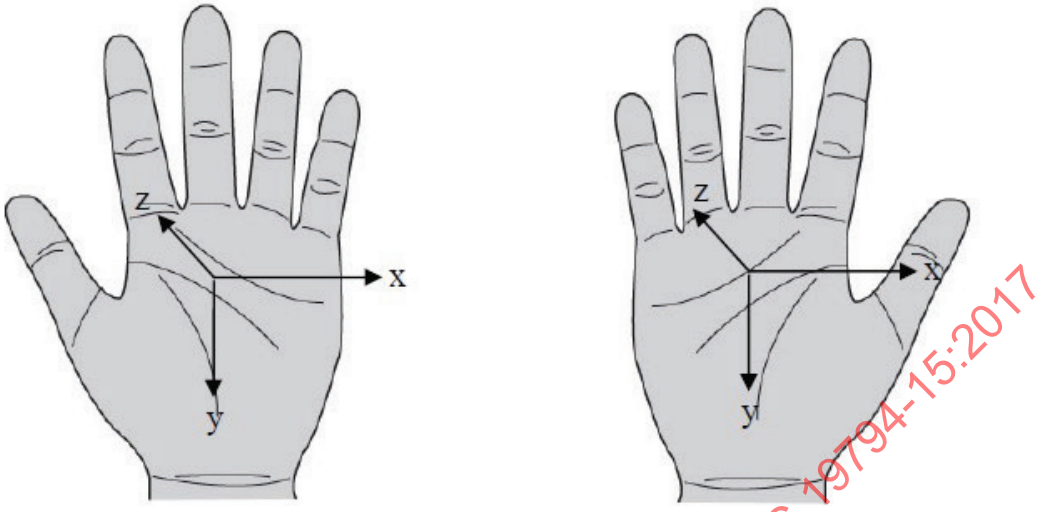
7.5 Report structure

Palm crease biometric technologies obtain images from the palm(s). Imaging location shall be specified in the data format. The palm direction (left/right) shall be specified in the data format. This document reserves fields for future development of technologies that may utilize different parts of human body.

7.6 Standard pose

The palm area shall not be bent and each distal crease 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.

Note that palm area shall not be bent, with exception to contact-less palm print technology which allows slight bending of the hand area.



NOTE The Euclidean direction is right-handed.

Figure 2 — Standard pose and object coordinate system of palm crease biometrics

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.

7.7 Occlusion by opaque artifacts

Some opaque artefacts (such as rings, bandages, etc.) may occlude palm crease patterns. Using images including occlusions should be avoided.

8 Palm crease image format specification

8.1 General data elements — Version

Table 1 — General data elements

Field	Item type	Valid values	Mandatory/Optional
Version	VersionType	Major = 1, Minor = 0	Mandatory

This version number shall consist of major version number and minor revision number. The format given in ISO/IEC 19794-1:2011/Amd 2:2015 shall be used. The version number of this document shall be major version 1 and minor revision 0.

8.2 Representation of specific data elements

8.2.1 Overview

Table 2 — Representation of specific data elements

Field	Item type	Valid values	Mandatory/Optional
Capture date and time	dateTime	—	Mandatory
Capture device type	CaptureDeviceType	See Table 3	Mandatory
Quality block	cmn:QualityType	See Table 5	Mandatory
Image type	ImagePartType	See Table 6	Mandatory
Image width	Unsigned Short	>0	Mandatory
Image height	Unsigned Short	>0	Mandatory
Bit-depth	BitDepthType	7 or 16	Mandatory
Image position and property	ImagePropertyType	See Table 7	Mandatory
Image color and compression	ImageFormatType	See Table 11	Mandatory
Illumination type	IlluminationType	See Table 13	Mandatory
Image background definition	BackgroundType	See Table 14	Mandatory
Horizontal scan resolution	Unsigned Short	<200	Mandatory
Vertical scan resolution	Unsigned Short	<200	Mandatory
Pixel aspect ratio	PicxelAspectRatioType	See Table 15	Mandatory

8.2.2 Capture date and time

The date and time of capture date. This field shall be stated in coordinated universal time (UTC). The format given in ISO/IEC 19794-1:2011/Amd 2:2015 shall be used for any absolute time values. This field shall be the XML built-in type "dateTime".

8.2.3 Capture device type

The capture device type field shall identify the product type that created the BDIR. It shall be assigned by the registered product owner or other approved registration authority. If the capture device vendor field is "Unreported", then the capture device type identifier shall be "Unreported" also.

Table 3 — Capture device type

Field	Item type	Valid values	Mandatory/Optional
Device ID	cmn:RegistryIDType	—	Mandatory
Certification	cmn:RegistryIDType	—	Mandatory
CaptureDeviceTechnology	String	See Table 4	Mandatory

The capture device technology field shall be encoded in string. This field shall indicate the class of capture device technology used to acquire the captured biometric sample. See Table 4 for the list of possible values.

Table 4 — Capture device technology value

Value
Unknown
NotSpecified
CCD/CMOS

8.2.4 Quality block

The quality block format is given in ISO/IEC 19794-1:2011/Amd 2:2015.

Table 5 — cmn:QualityType

Field	Item type	Valid values	Mandatory/Optional
Algorithm	cmn:RegistryIDType	—	Mandatory
Score	cmn:QualityScoreType	0 to 100, or "QualityCalculationFailed"	Mandatory

8.2.4.1 Quality score

Quality score, as defined in ISO/IEC 19794-1, 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 "QualityCalculationFailed" is to handle a special case. An entry of "QualityCalculationFailed" shall indicate a failed attempt to calculate a quality score. Multiple quality scores calculated by the same algorithm (same vendor and algorithm) shall not be present in a single representation.

8.2.4.2 Quality algorithm vendor

Quality algorithm vendor shall be registered with IBIA or other approved registration authority as a CBEFF biometric organization. A value of "Unreported" shall indicate that the quality algorithm vendor is unreported.

8.2.4.3 Quality algorithm

Quality algorithm may be optionally registered with IBIA or other approved registration authority as a CBEFF product code. A value of "Unreported" shall indicate that the quality algorithm is unreported.

8.2.5 Image type

This field specifies various body locations where palm crease images have been captured.

Table 6 — Image Type (ImagePartType) value

Value
Undefined
Palm All
Palm Part

8.2.6 Image width and image height

These two fields specify the horizontal and vertical image size in pixels.

8.2.7 Bit-depth

This field represents the number of bits per pixel in a grey scale image or the number of bits per colour components per pixel in an RGB image. The value of this field shall either be 7 or 16.

8.2.8 Image position and property

This field is a mandatory field specifying the position, direction, and properties of the palm crease image.

Table 7 — Image Property (ImagePositionType) type

Field	Item type	Valid values	Mandatory/Optional
Palm Direction	PalmDirectionType	See Table 8	Mandatory
Imaging Method	ImagingMethodType	See Table 9	Mandatory
Imaging Flip	ImageFlipType	See Table 10	Mandatory

8.2.8.1 Palm direction

This field specifies the palm direction.

Table 8 — Palm Direction (PalmDirectionType) value

Value	Note
HAND_UNDEF	
HAND_RIGHT	The right hand is scanned.
HAND_LEFT	The left hand is scanned.

8.2.8.2 Imaging method

This field specifies the imaging method.

Table 9 — Imaging Method (ImagingMethodType) value

Value	Note
IMAGING_UNDEF	
IMAGING_TRANSPARENCY	The type of imaging method is transparency imaging.
IMAGING_REFLECTANCE	The type of imaging method is reflectance imaging.

8.2.8.3 Imaging flip

This field specifies if the palm crease image is flipped (or not), and if flipped in which direction.

Table 10 — Imaging Flip (ImageFlipType) value

Value	Note
FLIP_UNDEF	
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.

8.2.9 Image colour and compression

This field specifies whether the image is monochrome or colour components and how the image has been compressed, if applicable.

Table 11 — Image format type

Field	Item type	Valid values	Mandatory/Optional
Image Compression	ImageCompressionType	See Table 12	Mandatory
Image Color	ImageColorType	See Table 12	Mandatory

Table 12 — Image colour and compression (ImageCompressionType, ImageColorType) value

Image compression	Image colour	Note
UNDEF	UNDEF	
RAW	MONOCHROME	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.
RAW	RGB	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.
JPEG	MONOCHROME	The image is monochrome and compressed using the JPEG algorithm as specified in ISO/IEC 10918 (all parts).
JPEG	RGB	The image is coloured and compressed using the JPEG algorithm as specified in ISO/IEC 10918 (all parts).
JPEC-LS	MONOCHROME	The image is monochrome and compressed using the JPEG-LS algorithm as specified in ISO/IEC 14495 (all parts).
JPEC-LS	RGB	The image is coloured and compressed using the PEG-LS lossless compression algorithm as specified in ISO/IEC 14495 (all parts).
JPEG2000	MONOCHROME	The image is monochrome and compressed using the JPEG2000 algorithm as specified in ISO/IEC 15444 (all parts).
JPEG2000	RGB	The image is coloured and compressed using the JPEG2000 algorithm as specified in ISO/IEC 15444 (all parts).
JPEG2000	MULTIPLANE	The image has more than three channels (multi-channel) and compressed using the JPEG2000 algorithm as specified in ISO/IEC 15444 (all parts).

8.2.10 Illumination type

This field is an informative optional field that specifies the capture device's illumination source. The type of illumination shall be categorized based on the wavelength of illumination source.

Table 13 — Illumination (IlluminationType) value

Value	Note
ILLUM_UNDEF	
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 illumination.

8.2.11 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. Otherwise this field shall have the value IMAGE_BACKGROUND_UNDEF.

Table 14 — Image background (BackgroundType) value

Value	Note
IMAGE_BACKGROUND_UNDEF	
IMAGE_BACKGROUND_MONO	The background of the image has been processed and set to monotone.

8.2.12 Horizontal scan resolution

This field specifies the scan resolution in the horizontal direction in 40 ppcm (100 ppi). If the horizontal scan resolution is not specified, this field shall contain the maximum resolution also be considered like 200 ppcm (500 ppi).

8.2.13 Vertical scan resolution

This field specifies the scan resolution in the vertical direction in 40 ppcm (100 ppi). If the vertical scan resolution is not specified, this field shall contain the maximum resolution also be considered like 200 ppcm (500 ppi).

8.2.14 Pixel aspect ratio

This field specifies the pixel aspect ratio.

Table 15 — Pixel aspect ratio type

Field	Item type	Valid values	Mandatory/Optional
AspectY	Unsigned Byte	—	Mandatory
AspectX	Unsigned Byte	—	Mandatory

8.3 Image data

This field contains the image data encoded by base64 algorithm.

8.4 Extended data

8.4.1 Extended data block function

This clause of the palm crease representation is open to placing additional data that may be used by the comparison system. The extended data for each palm crease representation shall immediately follow the standard image data for that palm crease representation. More than one extended data area may be present for each palm crease representation.

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 document. The intention of this document is to provide interoperability.

8.4.2 Extended data block

Table 16 — Extended data

Field	Item type	Valid values	Mandatory/Optional
Segmentation Data	SegmentationType	See Table 17	Optional
Annotation Data	AnnotationDataType	See Table 19	Optional
Comment Data	String	—	Optional

8.4.2.1 Segmentation data

This extended data section provides the locations for each of the image segments of the individual palm crease parts. Each palm crease segment shall be defined by the number of points used to define the segment and the coordinates of each point. This field shall specify the number of points or vertexes used to enclose the segmented image. For a palm crease segment defined by rectangle, this field shall contain a value of two coordinate pairs representing the upper-left and lower-right corners of the rectangle.

For a palm crease segment enclosed by an *n*-sided polygon, this byte shall contain "*n*" coordinate pairs. The order of the vertices shall be in their consecutive order around the perimeter of the polygon, either clockwise or counter clockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon shall be a simple, plane figure with no sides crossing and no interior holes. Each vertex of the rectangle or polygon shall be represented by a pair of coordinates.

Table 17 — Segmentation type

Field	Item type	Valid values	Mandatory/Optional
Number of point	Integer	≥2	Mandatory
Coordinate Pairs	CoordinatePairType	See Table 18	Mandatory

Table 18 — Coordinate pair type

Field	Item type	Valid values	Mandatory/Optional
X-Coordinate	Integer	>0	Mandatory
Y-Coordinate	Integer	>0	Mandatory

8.4.2.2 Annotation data

This field is provided to contain optional information about the palm crease contained in a larger palm crease image.

Table 19 — Annotation value

Value
AMPUTATED_HAND
BANDAGED
OTHER

8.4.2.3 Comment data

This field is provided to contain string information associated with the captured image or subject supplying the image. The comment is inputted by the individual generating the palm crease record.

9 Registered format type identifiers

The registration listed in Table 20 has been made with the CBEFF Registration Authority (see ISO/IEC 19785-1) to identify the palm crease image XML format. The format owner is ISO/IEC JTC 1/SC 37 with the registered format owner identifier 257 (0101_{Hex}).

Table 20 — Format type identifiers

CBEFF BDB Format type identifier	Short name	Full object identifier
33 (0021_{Hex})	Palm-crease-image	{iso(1) registration-authority(1) cbeff(19785) biometric-organization(0) jtc1-sc37(257) bdbs(0) palm-crease-image(33)}

Annex A
(normative)

Conformance testing methodology

A.1 Overview

This document specifies a biometric data interchange format for storing, recording, and transmitting one or more palm image representations. Each representation is accompanied by modality-specific metadata contained in a header record. This annex establishes tests for checking the correctness of the record.

The objective of this document cannot be completely achieved until biometric products can be tested to determine whether they conform to those specifications. Conforming implementations are a necessary prerequisite for achieving interoperability among implementations; therefore, there is a need for a standardized conformance testing methodology, test assertions, and test procedures as applicable to specific modalities addressed by each part of ISO/IEC 19794. The test assertions will cover as much as practical of the ISO/IEC 19794 requirements (covering the most critical features), so that the conformity results produced by the test suites will reflect the real degree of conformity of the implementations to ISO/IEC 19794 data interchange format records. This is the motivation for the development of this conformance testing methodology.

The testing methodology specified in ISO/IEC 19794-1:2013/Amd 1:2013, A.1, A.2 and A.3 shall apply. The content of the tables below is based on the conformance testing methodology outlined in ISO/IEC 19794-1/Amd 1:2013 and shall only be used in the context of that testing methodology.

For testing the conformance of an XML document claimed to conform to this document, the XML document shall be validated against the XML schema definition in Annex B.

A.2 Table of requirement in the base standard for conformance testing level 1 and 2

The normative requirements of this document are listed in Table A.1. The supplier of the IUT shall explain which optional components of the standard are supported and the testing laboratory shall note the results of the test.

Table A.1 may extend over multiple pages.

Table A.1 — Requirements of this document

Requirement ID	Reference in main body	Requirement summary	Level	Status	IUT support	Supported range	Test result
R-1	8.1	The version field shall be the Major version 1 and Minor version 0	2	M			

A.3 Table conformance test assertions

Table A.2 may extend over multiple pages.

Table A.2 — Conformance test assertions

Test no.	Section	Requirement ID	Level	Field name	Operator	Operand	Test note	Status	IUT rupport	Supported range	Test result
1	8.1	R-1	2	Version – Major version	EQ	1					
2	8.1	R-1	2	Version – Minor version	EQ	0					

Annex B
(normative)

XML schema

This annex, including the example of a Palm Image XML Schema, shall be customized and synchronized in conformity with the rules and definitions set by ISO/IEC 19794-1:2011/Amd 2:2015.

```
<?xml version="1.0" encoding="UTF-8"?>
<!--
Permission is hereby granted, free of charge in perpetuity, to any person obtaining a copy
of the Schema, to use, copy, modify, merge and distribute free of charge, copies of the
Schema for the purposes of developing, implementing, installing and using software based
on the Schema, and to permit persons to whom the Schema is furnished to do so, subject to
the following conditions: THE SCHEMA IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND,
EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR
COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN
ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE
SCHEMA OR THE USE OR OTHER DEALINGS IN THE SCHEMA. In addition, any modified copy of the
Schema shall include the following notice: THIS SCHEMA HAS BEEN MODIFIED FROM THE SCHEMA
DEFINED IN ISO/IEC 19794-15, AND SHOULD NOT BE INTERPRETED AS COMPLYING WITH THAT STANDARD
-->
<xs:schema
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns="http://standards.iso.org/iso-iec/19794/-15/ed-1"
    xmlns:cmn="http://standards.iso.org/iso-iec/19794/-1/ed-2/amd/2"
    targetNamespace="http://standards.iso.org/iso-iec/19794/-15/ed-1"
    elementFormDefault="qualified"
    attributeFormDefault="unqualified">
    <xs:annotation>
        <xs:documentation>This XML Schema contains all complex and simple type definitions
used in palm crease image data interchange.</xs:documentation>
    </xs:annotation>
    <xs:import schemaLocation="19794-1_ed2_amd2.xsd" namespace="http://standards.iso
.org/iso-iec/19794/-1/ed-2/amd/2"/>

    <xs:element name="PalmCreaseImage">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Version" type="cmn:VersionType"/>
                <xs:element name="RepresentationList">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="Representation"
type="PalmCreaseImageRepresentationType"
                                maxOccurs="unbounded"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute ref="cmn:SchemaVersion" use="required" />
        </xs:complexType>
    </xs:element>

    <xs:complexType name="PalmCreaseImageRepresentationType">
        <xs:sequence>
            <xs:element name="CaptureDateTime" type="xs:dateTime"/>
            <xs:element name="CaptureDevice" type="PalmCreaseImageCaptureDeviceType"/>
            <xs:element name="QualityList" minOccurs="0">
                <xs:complexType>
                    <xs:sequence>
                        <xs:element name="Quality" type="cmn:QualityType"
                            maxOccurs="unbounded"/>
                    </xs:sequence>
```

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                </xs:complexType>
            </xs:element>
            <xs:element name="ImagePart" type="ImagePartType"/>
            <xs:element name="ImageWidth" type="xs:unsignedShort”/>
            <xs:element name="ImageHeight" type="xs:unsignedShort”/>
            <xs:element name="BitDepth" type="BitDepthType"/>
            <xs:element name="ImagePosition" type="ImagePositionType"/>
            <xs:element name="RotationAngle" type="xs:unsignedShort”/>
            <xs:element name="ImageFormat" type="ImageFormatType"/>
            <xs:element name="Illumination" type="IlluminationType"/>
            <xs:element name="Background" type="BackgroundType"/>
            <xs:element name="HorizontalScanResolution" type="xs:unsignedShort”/>
            <xs:element name="VerticalScanResolution" type="xs:unsignedShort”/>
            <xs:element name="PixelAspectRatio" type="PixelAspectRatioType"/>
            <xs:element name="PalmCreaseImageData" type="xs:base64Binary”/>
            <xs:element name="ExtendedData" type="ExtendedDataType" minOccurs="0"
maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="PalmCreaseImageCaptureDeviceType">
        <xs:sequence>
            <xs:element name="CaptureDeviceModelID" type="cmn:RegistryIDType”/>
            <xs:element name="CaptureDeviceTechnologyID"
type="PalmCreaseImageCaptureDeviceTechnologyIDType"/>
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="PalmCreaseImageCaptureDeviceTechnologyIDType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="Unknown"/>
            <xs:enumeration value="CCD/CMOS"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="ImagePartType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="Undefined"/>
            <xs:enumeration value="Palm All"/>
            <xs:enumeration value="Palm Part"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="BitDepthType">
        <xs:restriction base="xs:unsignedByte">
            <xs:enumeration value="7"/>
            <xs:enumeration value="16"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="PalmDirectionType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="HAND_UNDEF"/>
            <xs:enumeration value="HAND_RIGHT"/>
            <xs:enumeration value="HAND_LEFT"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="ImagingMethodType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="IMAGING_UNDEF"/>
            <xs:enumeration value="IMAGING_TRANSPARENCY"/>
            <xs:enumeration value="IMAGING_REFLECTANCE"/>
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="ImageFlipType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="FLIP_UNDEF"/>
            <xs:enumeration value="FLIP_NONE"/>
            <xs:enumeration value="FLIP_HORIZONTAL"/>
```