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Working Draft 2

Information technology - Conformance Testing Methodology Standard for Biometric Data Interchange Format Standards - Part 6: Conformance Testing Methodology for INCITS 379, Iris Image Interchange Format

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Foreword

INCITS (The International Committee for Information Technology Standards) is the American National Standards Institute (ANSI) recognized standards development organization for information technology within the United States of America. Members of INCITS are drawn from Government, Corporations, Academia and other organizations with a material interest in the work of INCITS and its Technical Committees. INCITS does not restrict membership and attracts participants in its technical work from 13 different countries, and operates under the rules of the ANSI. In the field of Biometrics, INCITS has established the Technical Committee M1. Standards developed by this Technical Committee have reached consensus throughout the development process and have been thoroughly reviewed through several Public Review processes. In addition, the INCITS Executive Board and ANSI Board of Standards Review have approved this American National Standard for Publication as an ANSI/INCITS Standard. Requests for interpretation, suggestions for improvement or addenda, or defect reports are welcomed and should be sent to the editor

Introduction

The INCITS M1 Iris Image Interchange Format provides an industry standard to allow for iris images captured with one vendor's iris image capture technology to be useful to another vendor's iris template generation and matching algorithms. The capability to assure that a vendor's iris image data records conform to this standard is critical to its widespread adoption and use.

For the purposes of this standard, conformance will be tested as described in Part 1 of this multipart standard. There will be conformance testing for Level 1 (Data format conformance) and Level 2 (Internal Consistency Checking). Level 3 testing (Content Checking) is the subject of ongoing research and is not included in this version of this standard.

A particular iris image data record based on either the rectilinear or polar format can be considered in conformance to the specification. In this case, a data record can be parsed and examined to assure that the data configuration is consistent with the specification. A process that transforms a conformant rectilinear image data record into a polar image data record can conform to this specification by producing a conformant polar format data record. A process that matches an incoming image to an iris enrollment database can conform to this specification by accepting as input a conformant rectilinear or polar iris image data record.

This test specification is intended to act as an unbiased implementation-independent test suite to expose where a given process does not conform to the ANSI INCITS 379-2004 iris image interchange format. Specifically this document will:

a) provide a framework for iris image interchange testing activities so that it is clear what will be tested and what the sequence of the test activities will be,

b) define the scope of the testing,

c) ensure that there is not any unnecessary duplication of testing effort, and

d) document a consistent and maintainable test case style.

1 Scope

This document specifies the testing activities required to assure a vendor's application or service's conformance to the Iris Image Interchange Format. This standard is intended to:

a) establish a framework for Conformance Testing Methodology for vendors of products and services that utilize the ANSI INCITS 379-2004 standard,

b) define requirements and guidelines for specifying conformance test suites and related test methods for measuring conformity of products and services to the ANSI INCITS 379-2004 standard, and

c) define test procedures to be followed before, during, and after conformance testing.

2 Conformance

Data interchange format conformance tests that claim conformance to this standard shall satisfy the normative requirements of the methodology for those levels of test they are claiming to perform, as described in Section 5.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI INCITS 398-2005 Information technology – Common biometric exchange formats framework (CBEFF)

ANSI INCITS 379-2004 Information technology – Iris image interchange format

4 Terms and definitions

4.1 Terms defined in Part 1

For the purposes of this document, the following terms defined in Part 1 apply:

- Assertion
- Biometric Data Interchange Record (BIDR)
- Conformance
- Conformance testing
- Conformance Test Suite (CTS)
- Implementation Under Test (IUT)
- Input Biometric Data Record (IBDR)
- Type A - Produce Conformant BDIR (Type A or PCB)
- Type B - Use Conformant BDIR (Type B or UCB)

4.2 Other terms and definitions

4.2.1

canthus
angle formed by the meeting of the upper and lower eyelids at either side of the eye

4.2.2

nasal
pertaining to the side of the eye closest to the nose

4.2.3

polar
arranged in a coordinate system based on radial distance and angular position

4.2.4

pupil
the aperture or opening in the center of the iris that through which light passes to the retina

4.2.5

rectilinear
arranged in a coordinate system based on horizontal and vertical axes

4.2.6

rotation angle
angular position of the interpupilary line relative to the horizontal

4.2.7

rotation uncertainty
expected maximum error in the recorded rotation angle

5 Iris image conformance testing

5.1 General

Part 1 of this standard describes a three level testing hierarchy. Level 1 conformance testing addresses data format conformance. BDIRs produced by an IUT are examined to confirm that all required data fields are included and that the values within those fields are within allowed ranges. In this case of iris image data, conformant BDIR's would be produced directly by a capture device, by vendor software that transforms images captured in some other format to a conformant format, or by vendor software that transforms conformant rectilinear format BDIRs to conformant polar format BDIRs. Level 2 conformance testing addresses the internal consistency of the data within the BDIR fields. Finally, Level 3 testing assesses the fidelity of the information in the BDIR relative to the IBDR that was used to produce it. In this latter case the IBDR could be a raw input image in some standard or proprietary format that is used to produce either a rectilinear or polar format BDIR. Alternatively, the IBDR could be a rectilinear format BDIR that is further processed to produce a polar format BDIR. Fidelity of the information in a rectilinear format BDIR would be an issue only in cases where the input image was compressed using a lossy algorithm as part of the transformation process. The generation of a polar format BDIR from a rectilinear IBDR is more complex, because it may require determination of the pupil and outer iris boundaries in the input image and resampling of the iris image to convert from rectilinear to polar coordinates. The

specification of Level 3 tests is the subject of ongoing research, and is outside the scope of this version of this standard.

5.2 Conformance test types

The types of conformance tests that must be performed fall into three major categories that are described further in the following subsections. Testing of the ability of an IUT to produce a conforming BIDR, or Type A testing, can be performed simply by examining BIDRs produced by the IUT. Type A testing focuses on the data format and values in the BIDR, and most conveniently includes both Level 1 and Level 2 testing. The second category includes tests used to assess an IUTs ability to use a conforming BIDR, or Type B testing. These tests use BIDRs that have passed Type A testing, and confirm that the IUT can successfully interpret those BIDRs, and use the data they contain to perform biometric operations such as enrollment, verification, and identification. Both Type B testing and Level 3 testing are the subjects of ongoing research and are not included in this version of this standard.

5.3 Type A conformance testing

5.3.1 Type A conformance requirements

TYPE A conformance testing includes Level 1 testing, in which individual data elements are examined to confirm that they are present, if mandatory, and that the values contained are within required ranges. TYPE A testing also includes Level 2 testing, in which the values within the BIDR are examined and compared to confirm that they are consistent.

5.3.2 Iris data record structure

Each iris image data record begins with a record header that contains information about the size, format, etc. of all of the images in the record. The record header is followed by either one or two iris feature headers, each one containing information about which eye was imaged to produce the data, and how many images of that eye are contained in the record. One or more iris images follows each feature header, with each image preceded by an iris image header that contains data specific to the image.

5.3.3 Iris record header data elements

5.3.3.1 Format identifier

The first four bytes of the record shall contain the format identifier 0x49495200, the ASCII encoded characters “IIR” followed by the null terminator.

5.3.3.2 Header version

Bytes 5–8 shall contain three ASCII numbers, the first two specifying the major version number and the third the minor version number, followed by the null terminator. For the initial release of the standard the version number is 1.0, therefore the value in this field shall be 0x30313000.

5.3.3.3 Record length

Bytes 9-12 shall contain the entire length of the data record in bytes encoded in big endian format. Conformance shall be assessed by comparing the record length header to the total size of the data record.

5.3.3.4 CBEFF product identifier

Bytes 13-16 shall contain a four-byte value that identifies the product or device used to generate the BDIR. This identifier is assigned by the product or device manufacturer. This field is provided

as a convenience to the producer of the data and no specific conformance assessment is required.

5.3.3.5 Capture device identifier

Bytes 17-18 shall contain a unique identification number for the image capture device used to originally acquire the image. This identifier is assigned by the device manufacturer and no specific conformance assessment is required.

5.3.3.6 Number of iris features

Byte 19 shall contain a value of 1 or 2, indicating the number of eyes that were imaged in order to produce the images contained in the BDIR. Conformance shall be assessed by examining the images contained in the data record and confirming that the number of different eyes observed agrees with the value in this field.

5.3.3.7 Record header length

Bytes 20-21 shall contain the length of the record header in bytes encoded in big-endian format. The value shall be 65 decimal or 0x41.

5.3.3.8 Iris image properties bitfield

Bytes 22-23 shall contain a 16-bit field that encodes binary values signifying properties of the images contained in the BDIR. Conforming values are listed in Table 1. Conformance shall be assessed by examining images to confirm that correct values are provided. If a horizontal flip is required the nasal canthus (the corner of the eye closest to the nose) of a left eye image will appear on the right side of the image and the nasal canthus of a right eye image will appear on the left side of the image (see also 5.3.4.1). If a vertical flip is required the image of the eye will be inverted.

Table 1 – Image properties bitfield

Bit Position	Bit Value			
	00	**01**	**10**	**11**
1-2 Horizontal orientation	Undefined	No correction required	Horizontal image flip required	Reserved
3-4 Vertical orientation	Undefined	No correction required	Vertical image flip required	Reserved
5-6 Scan type	Undefined	Progressive – all image lines sequential	Image generated from two interlaced fields	Image generated from one interlaced field using line duplication
7 Iris occlusions (polar format)	Undefined	Occluded pixels marked		
8 Occlusion filling (polar format)	Occluded pixels marked with zero intensity	Occluded pixels marked with maximum intensity		
9 Boundary extraction (polar format)	Undefined	Iris boundaries extracted prior to polar image generation		
10-16	Reserved	Reserved	Reserved	Reserved

5.3.3.9 Iris diameter

Bytes 24-25 shall contain the expected iris diameter in pixels. The range of permissible values is 1–65,535. In polar format data records this field is not used and may contain any value. Conformance shall be assessed by measuring the iris diameter in the image and confirming that the absolute value of the difference between the actual diameter and the expected diameter is not more than 20 percent of the expected diameter.

5.3.3.10 Image format

Bytes 26-27 shall contain a 16-bit field that encodes binary values signifying the format of the image data contained in the BDIR. Conforming values are listed in Table 2. Conformance shall be assessed by examining the images to confirm that the format value is correct.

Table 2 Image format field

Image format	Value (hex)
Monochrome, raw data	0x0002
RGB color, raw data	0x0004
Monochrome, JPEG format	0x0006
Color, JPEG format	0x0008
Monochrome, JPEG-LS format	0x000A
Color, JPEG-LS format	0x000C
Monochrome, JPEG2000	0x000E
Color, JPEG2000	0x0010

5.3.3.11 Image width

Bytes 28-29 shall contain the image width in pixels for raw images. The range of allowed values shall be 0-65,535. The value may be zero only if the image format used supports an internal header that contains the image dimensions. Conformance shall be assessed by displaying the raw image using the provided value and confirming that it is displayed correctly.

5.3.3.12 Image height

Bytes 30-31 shall contain the image height in pixels for raw images. The range of allowed values shall be 0-65,535. The value may be zero if the image format used supports an internal header that contains the image dimensions. Conformance shall be assessed by displaying the raw image using the provided value and confirming that it is displayed correctly.

5.3.3.13 Intensity depth

Byte 32 shall contain the image depth in bits for each color. The range of allowed values shall be 0-255. The value may be zero if the image format used supports an internal header that contains the image dimensions. Conformance shall be assessed by displaying the raw image using the provided value and confirming that it is displayed correctly.

5.3.3.14 Image transformation

Byte 33 shall contain a value of 0 or 1 with the value 1 indicating that the transformation from rectilinear to polar coordinates used linear interpolation of radial samples along a line from the i^{th} angular point on the pupil boundary to the i^{th} angular sample on the iris boundary, where the boundaries are defined by best-fit circles that are not necessarily concentric. The value 0 shall indicate that the transformation is undefined. This entry is used only for polar format data records. Conformance shall be assessed by confirming that for polar format data records a value of either 0 or 1 is entered.

5.3.3.15 Device unique identifier

Bytes 34-49 shall contain a 16 character ASCII-encoded string uniquely identifying the device or source of the data. A value of all zeros is conformant. This field is provided as a convenience to the producer of the data and no specific conformance assessment is required.

5.3.3.16 Globally unique identifier (GUID)

Bytes 50-65 shall contain a 16 character ASCII-encoded string uniquely identifying the data record. A value of all zeros is conformant. This field is provided as a convenience to the producer of the data and no specific conformance assessment is required.

5.3.4 Iris feature header data elements

5.3.4.1 Iris feature

The first byte of the iris feature header shall contain the value 0, 1, or 2. A value of 0 indicates that no information is available about which eye was imaged to generate the data. A value of 1 shall indicate that the following images were derived from the right eye. A value of 2 shall indicate that the following images were derived from the left eye. Conformance shall be assessed by visually examining the images that follow the header to confirm that the eye is identified correctly. In a right eye image that does not require horizontal flipping (see 5.2.3.8) the nasal canthus (the corner of the eye closest to the nose) shall appear on the right side of the image. In a left eye image that does not require horizontal flipping the nasal canthus shall appear on the left side of the image.

5.3.4.2 Number of images

Bytes 2-3 of the iris feature header shall contain the number of images provided of the eye identified in the iris feature field (see 5.2.4.1). Allowed values shall be 1–65,535. Conformance shall be assessed by visually examining the images contained in the data record and confirming that the correct number of images is present.

5.3.5 Iris image header data elements

5.3.5.1 Image number

Bytes 1-2 of the iris image header shall contain the sequence number for each image sample. Allowed values shall be 1–65,535. Each image shall be numbered sequentially, and the number of the last image sample (for the current feature) shall be equal to the value in the number of images field in the iris feature header (see 5.2.4.2). Conformance shall be assessed by confirming that the image number values are sequential and consistent with the data in the iris feature header.

5.3.5.2 Quality

Byte 3 of the iris image header shall contain the quality value for the image sample. Allowed values shall be 1–100 or 254. A value of 254 (0xFE hex) shall indicate that the quality value is undefined. Conformance shall be assessed by confirming that the field contains an allowed value.

5.3.5.3 Rotation angle

Bytes 4-5 of the iris image header shall contain a scaled rotation angle value between 0 and 65,535. The value 0 shall correspond to 0 degrees, and 65,534 shall correspond to 360 degrees. A value of 65,535 (0xFFFF hex) shall indicate that the rotation angle is undefined. Polar format data records shall contain a value of 65,535, indicating that the angle is undefined. Conformance shall be assessed by confirming that the value falls within the allowed range for the data record format used.

5.3.5.4 Rotation uncertainty

Bytes 6-7 of the iris image header shall contain a scaled rotation uncertainty value between 0 and 65,535. The value 0 shall correspond to 0 degrees, and 65,534 shall correspond to 180 degrees. A value of 65,535 (0xFFFF hex) shall indicate that the rotation uncertainty is undefined. Rotation uncertainty refers to the absolute value of the maximum error in the rotation angle value (see 5.2.5.3). If the rotation angle value is undefined then the rotation uncertainty shall be undefined as well. Conformance shall be assessed by confirming that the value falls within the allowed range for the data record format used, and that the value is consistent with the rotation angle value.

5.3.5.5 Image length

Bytes 8–11 of the iris image header shall contain the size of the image data in bytes. Allowed values are 1–4,294,967,295. Conformance shall be assessed by confirming that the value falls within the allowed range and is consistent with the image format (see 5.2.3.10); the image height, width, and intensity depth, if provided (see 5.2.3.11 through 5.2.3.13); and/or the image dimensions contained in internal image headers, if used.

Annex A

(normative)

A.1 Level 1 and 2 assertions for INCITS 379-2004

The specific test assertions required for Level 1 and 2 conformance testing of INCITS 379-2004, Iris Image Interchange Format are listed in Table A.1. References are to specific sections of INCITS 379-2004.

Table A.1 Test assertions

Test	Field	Operator	Operands	Conditional	References	Level
1	Format Identifier	EQ	0x49495200		5.5.1	1
2	Version	EQ	0x30313000		5.5.1	1
3	Record Length	EQ	65 – (2^{16}-1)		5.5.1	1
3.1	Record Length	EQ	Total bytes read		5.5.1	2
3.2	Record Length	EQ	Total bytes expected (Note 1)		5.5.1	2
4	CBEFF PID Owner	NEQ	0		5.5.4	1
5	CBEFF PID Type	NONE			5.5.4	
6	Capture Device ID	NONE			5.5.5	
7	No. of Iris Features	EQ	1 - 2		5.5.1	2
8	Record Header Length	EQ	65		5.5.1	1
9	Image Properties	LE	255		5.5.1	1
9.1	Bits 1-2 Horiz Orientation	EQ	0 - 2		5.5.1	1
9.2	Bits 3-4 Vert Orientation	EQ	0 - 2		5.5.1	1
9.3	Bits 5-6 Scan Type (Rectilinear format)	EQ	0 - 3	YES	5.3.2.4	1
9.4	Bit 7 Iris Occlusions (Polar format)	EQ	0 – 1	YES	5.3.2.3	1
9.5	Bit 8 Occlusion Filling (Polar format)	EQ	0 – 1	YES	5.3.2.3	1
9.6	Bit 9 Boundary Extraction (Polar format)	EQ	0 – 1	YES	5.3.2.1, 5.3.2.2	1
10	Expected Iris Diameter (Rectilinear format)	EQ	0 – 255	YES	5.5.1	1
11	Image Format	LE	255		5.5.1	1
11.1	Monochrome, raw	EQ	2		5.2.2	2
11.2	RGB, raw	EQ	4		5.2.2	2
11.3	Mono, JPEG	EQ	6		5.2.4	2
11.4	RGB, JPEG	EQ	8		5.2.4	2
11.5	Mono, JPEG_LS	EQ	10		5.2.3	2
11.6	RGB, JPEG_LS	EQ	12		5.2.3	2
11.7	Mono, JPEG2000	EQ	14		5.2.3, 5.2.4	2
11.8	RGB, JPEG2000	EQ	16		5.2.3, 5.2.4	2
12	Image Width	EQ	1 – 65,535		5.5.1	2
13	Image Height	EQ	1 – 65,535		5.5.1	2
14	Intensity Depth	EQ	1 – 255		5.5.1	2
15	Image Transformation (Polar format)	EQ	0 – 1	YES	5.5.6	1
16	Device Unique Identifier	NONE			5.5.1	1
17	GUID	NONE			5.5.1	1
18	Feature	EQ	0 – 2		5.5.2	2
19	Number of Images	EQ	1 – 65,535		5.5.2	2

Table A.1 Test assertions *(continued)*

Test	Field	Operator	Operands	Conditional	References	Level
20	Image Number	EQ	1 – Number of Images		5.5.3	2
21	Quality	EQ	26 – 100 or 254		5.5.3	1
22	Rotation angle (Rectilinear format)	EQ	0 – 65,535	YES	5.5.3	1
22.1	Rotation angle (Polar format)	EQ	65,535	YES	5.5.3	1
23	Rotation uncertainty	EQ	0 – 65,535		5.5.3	1
24	Image length	EQ	1 – (2^{32} – 1)		5.5.3	2

A.2 Test Notes

A.2.1 Note 1 (3.2) – {Record Length} EQ {Total Bytes Expected}

The Total Bytes Expected is calculated as follows. Note that 65 is the length of the record header, 3 the length of each feature header, and 11 the length of each image header.

SUM = 65

FOR M = 1 TO {Number of Iris Features}

    SUM = SUM + 3

    FOR N = 1 TO {Number of Images (M)}

        SUM = SUM + 11 + Image Length (N)

    END

END

Total Bytes Expected = SUM