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Information technology — Biometric data interchange formats —

Part 2: Finger minutiae data

AMENDMENT 1: Detailed description of finger minutiae location, direction, and type

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

Partie 2: Données du point caractéristique du doigt

AMENDEMENT 1: Description détaillée du point caractéristique du doigt, direction et type

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Foreword

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

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

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

Amendment 1 to ISO/IEC 19794-2:2005 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

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IMPORTANT — The electronic file of this document contains colours which are considered to be useful for the correct understanding of the document. Users should therefore consider printing this document using a colour printer.

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Insert the following new annex after D.3:

Annex E
(informative)

Detailed description of finger minutiae location, direction, and type

E.1 Scope

Even if all conform to this part of ISO/IEC 19794, different minutiae data blocks extracted from the same finger image may differ not only in the exact locations, the directions, and the types of those minutiae that they have in common, but also in the number of minutiae they contain, especially in blurred fingerprint regions where even the "manual" detection of minutiae is hard. The description of the minutia location in 6.4 refers to a single-pixel-wide skeleton of the friction ridges. The minutia direction is defined in 6.4, based on tangents to the skeleton. The skeletonisation algorithm itself is not described and also the method to determine the tangents is left open.

The scope of this informative annex is to provide a more precise definition of location, direction, and type of minutiae in gray-scale finger images and a detailed description of the quality field. It enhances the readability of this part of ISO/IEC 19794 and decreases the possibility of misinterpretation. The standardisation of algorithms is out of scope of this informative annex. This informative annex does not supersede the existing standard.

E.2 Terms and definitions

For the purposes of this informative annex, the following terms and definitions apply.

E.2.1
4-neighbour of a pixel *p*
pixel that is the top, bottom, left, or right neighbour of *p*

EXAMPLE The pixels *e*, *f*, *g*, and *h* in Figure E.1 are 4-neighbours of pixel *p*.

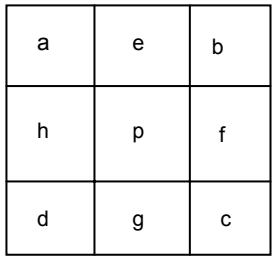

Figure E.1 — 4- and 8-neighbours of a pixel *p*

E.2.2
4-path from pixel p_0 to pixel p_n
sequence of pixels (p_0, p_1, p_2, …, p_n) such that p_i is a 4-neighbour of p_{i-1}

E.2.3
4-connected set of pixels
set *S* of pixels such that for any two pixels p, $q \in S$ there exists a 4-path from *p* to *q*

E.2.4
8-neighbour of a pixel *p*
pixel that is a 4-neighbour or a diagonal (top-left, top-right, bottom-left, or bottom-right) neighbour of *p*

EXAMPLE The pixels *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* in Figure E.1 are 8-neighbours of pixel *p*.

E.2.5
8-path from pixel p_0 to pixel p_n
sequence of pixels (p_0, p_1, p_2, …, p_n) such that p_i is an 8-neighbour of p_{i-1}

E.2.6
8-connected set of pixels
set *S* of pixels such that for any two pixels p, $q \in S$ there exists an 8-path from *p* to *q*

E.2.7
border ∂S of a set of pixels *S*
subset $\partial S = \{x \in S : x \text{ is 4-neighbour of } q, q \notin S\}$ of pixels of *S* that are 4-neighbours of pixels outside *S*

E.3 Minutiae detection strategy

E.3.1 "Liberal-conservative" spectrum

Minutia detection algorithms may use different discriminative practices in the minutia detection strategy. A liberal minutia detection strategy is supposed to detect a large number of minutiae which will increase the probability to include spurious minutiae while a conservative strategy will detect only a few minutiae and increase the probability to miss some. The following subclauses provide an explanation of some types of spurious (false) minutiae which may result from the use of a 'liberal' strategy but which may not be detected if a more 'conservative' strategy is employed.

The following images show examples of applying a conservative or liberal minutia detection strategy to the same sample images. These examples are not meant to suggest a liberal or conservative strategy. The best detection strategy for a particular application depends on the business processes and their associated security requirements that the biometric components of the system are designed to support or enable.

Figure E.2 — Liberal minutia detection (left) versus conservative minutia detection (right)

Figure E.3 — Liberal minutia detection (left) versus conservative minutia detection (right)

Figure E.4 — Liberal minutia detection (left) versus conservative minutia detection (right)

Figure E.5 — Liberal minutia detection (left) versus conservative minutia detection (right)

Figure E.6 — Liberal minutia detection (left) versus conservative minutia detection (right)

E.3.2 Fingerprint boundary

No minutia should be set outside the fingerprint boundary.

Minutiae may be set below the first phalange, even it is not the usual case.

E.3.3 Sweat pore

No minutia should be set at a sweat pore. A pore could happen to lie at the position of the forking of a friction ridge (bifurcation, see Figure E.16 below), but a sweat pore without connectivity to three legs must not be misinterpreted as a minutia.

E.3.4 Touching ridges

No minutia should be set where thick ridges touch each other.

E.3.5 Incipient ridge

No minutia should be set at an incipient (very short and thin) ridge.

E.3.6 Crease

No minutia should be set at a crease (accidental interruption of ridges).

E.3.7 Core

No minutia should be set at a core.

A core represents a singularity in the direction field, hence a proper angle value cannot be assigned to this location.

NOTE Information about cores can be expressed in a standardised way in the extended data block (see 8.5.3).

E.3.8 Delta

No minutia should be set at a delta.

A delta represents a singularity in the direction field, hence a proper angle value cannot be assigned to this location.

NOTE Information about deltas can be expressed in a standardised way in the extended data block (see 8.5.3).

E.4 Minutia characteristics

E.4.1 Rationale

This document shall not standardize certain algorithms as laid down in the scope. The guidelines to find the best minutia position and location require some methodology in description. Examples of two independent methods for determining the location and orientation of minutiae are presented in this document. The first is commonly known as the ridge gradient method while the second is referred to as the valley skeletal bifurcation method, which is popular in the AFIS industry. Without loss of generality, the ridge gradient method will focus on ridge ends and ridge bifurcations and the valley skeletal bifurcation method will describe valley bifurcations and ridge bifurcations in this document, i.e. the choice of the method finally depends on the specific format type to be used.

E.4.2 Minutia type

The minutia type cannot be determined reliably in some occasions.

EXAMPLE Due to varying contact pressure while acquiring the fingerprint and due to different image binarisation approaches, a ridge ending may join an adjacent ridge, giving the impression of a ridge bifurcation.

The minutiae type “other” should only be used if neither of the other two minutiae types, “ridge ending” and “ridge bifurcation”, can reliably be assigned to a minutia.

E.4.3 Minutia location tools

E.4.3.1 Consideration of the resolution of the underlying finger image

For the minutiae location, a correct handling of the resolution of the underlying finger image is important. The minutiae extraction algorithm should be able to determine the resolution of the underlying finger image in a reliable way (e.g. from a fingerprint-sensor configuration file). For minutiae data in the finger minutiae record format, this resolution shall be stored in the X and Y resolution fields within the record header. For minutiae data in the on-card-biometric-comparison format, the resolution of the underlying finger image shall be used when calculating the X and Y coordinates of the location in the prescribed metric dimension units out of their pixel values. For conversion between format types, the resolution shall be taken from, or stored in, the X and Y resolution fields within the record header.

E.4.3.2 Image binarisation

Every gray scale fingerprint image can be transformed into a binary image. This is common practice in image processing. Every pixel is assigned black if its gray scale value is darker than a threshold (such as the average gray scale value) and white if its gray scale value is lighter than the threshold. Most professional finger image processing implementations use sophisticated methods such as location-dependent thresholds to come to a binary image. A binary image separates the image pixels into two categories: ridges and valleys. Without loss of generality, black pixels refer to ridges in the following text.

captured raw image binary image (truncated)

Figure E.7 — Raw image vs. binary image

E.4.3.3 Image skeletonization

Skeletonization is a standard procedure in graphing practice. It produces a single-pixel-wide skeleton from a binary image. Several skeletonization methods are reported in literature. The process yields either a 4-connected or 8-connected skeleton. Figure E.8 shows a sample image and its skeleton.

Figure E.8 — Binary image and ridge skeleton, from [14]