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Information technology — JPEG XR image coding system —

Part 2: Image coding specification

Technologies de l'information — Système de codage d'image JPEG XR —

Partie 2: Spécification de codage d'image

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Contents

Page

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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) or the IEC list of patent declarations received (see http://patents.iec.ch).

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

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. The technically identical text is published as Rec. ITU-T T.832.

This fourth edition cancels and replaces the third edition (ISO/IEC 29199-2:2012), which has been technically revised. It also incorporates the Amendment ISO/IEC 29199-2:2012/Amd.1:2017.

The main changes compared to the previous edition include:

— the specification of additional colour type identifiers;

— the specification of an alternative file storage format based on ISO/IEC 23008-12 for the storage and interchange of JPEG XR coded images and image sequences;

— the specification of media type identifiers for use for use in various internet protocols.

A list of all parts in the ISO/IEC 29199 series can be found on the ISO website.

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

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Introduction

This document specifies requirements and implementation guidelines for the compressed representation of digital images for storage and interchange in a form referred to as JPEG XR. The JPEG XR design provides a practical coding technology for a broad range of applications with excellent compression capability and important additional functionalities. An input image is typically operated on by an encoder to create a JPEG XR coded image. The decoder then operates on the coded image to produce an output image that is either an exact or approximate reconstruction of the input image.

The primary intended application of JPEG XR is the representation of continuous-tone still images such as photographic images. The manner of representation of the compressed image data and the associated decoding process are specified. These processes and representations are generic, that is, they are applicable to a broad range of applications using compressed colour and grayscale images in communications and computer systems and within embedded applications, including mobile devices.

As of 2008, the most widely used digital photography format is a nominal implementation of the first JPEG coding format as specified in ITU-T Recommendation T.81 | ISO/IEC 10918-1. This encoding uses a bit depth of 8 for each of three channels, resulting in 256 representable values per channel (a total of 16 777 216 representable colour values).

More demanding applications may require a bit depth of 16, providing 65 536 representable values for each channel, and resulting in over $2.8 * 10^{14}$ colour values. Additional scenarios may necessitate even greater bit depths and sample representation formats. When memory or processing power is at a premium, as few as five or six bits per channel may be used.

The JPEG XR specification enables greater effective use of compressed imagery with this broadened diversity of application requirements. JPEG XR supports a wide range of colour encoding formats including monochrome, RGB, CMYK and n-component encodings using a variety of unsigned integer, fixed point, and floating point decoded numerical representations with a variety of bit depths. The primary goal is to provide a compressed format specification appropriate for a wide range of applications while keeping the implementation requirements for encoders and decoders simple. A special focus of the design is support for emerging high dynamic range (HDR) imagery applications.

JPEG XR combines the benefits of optimized image quality and compression efficiency together with low-complexity encoding and decoding implementation requirements. It also provides an extensive set of additional functionalities, including:

— high compression capability;

— low computational and memory resource requirements;

— lossless and lossy compression;

— image tile segmentation for random access and large image formats;

— support for low-complexity compressed-domain image manipulations;

— support for embedded thumbnail images and progressive resolution refinement;

— embedded codestream scalability for both image resolution and fidelity;

— alpha plane support;

— bit-exact decoder results for fixed and floating point image formats.

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Important detailed design properties include:

— high performance, embedded system friendly compression;

— small memory footprint;

— integer-only operations with no divides;

— a signal processing structure that is highly amenable to parallel processing;

— use of the same signal processing operations for both lossless and lossy compression operation;

— support for a wide range of decoded sample formats (many of which support high dynamic range imagery):

  — monochrome, RGB, CMYK or n-component image representation;

  — 8- or 16-bit unsigned integer;

  — 16- or 32-bit fixed point;

  — 16- or 32-bit floating point;

  — several packed bit formats;

  — 1-bit per sample monochrome;

  — 5- or 10-bit per sample RGB;

  — radiance RGBE.

The algorithm uses a reversible hierarchical lifting-based lapped biorthogonal transform. The transform has lossless image representation capability and requires only a small number of integer processing operations for both encoding and decoding. The processing is based on 16 × 16 macroblocks in the transform domain, which may or may not affect overlapping areas in the spatial domain (with the overlapping property selected under the control of the encoder). The design provides encoding and decoding with a minimal memory footprint suitable for embedded implementations.

The algorithm provides native support for both RGB and CMYK colour types by converting these colour formats to an internal luma-dominant format through the use of a reversible colour transform. In addition, YUV, monochrome and arbitrary n-channel colour formats are supported.

The transforms employed are reversible; both lossless and lossy operations are supported using the same algorithm. Using the same algorithm for both types of operation simplifies implementation, which is especially important for embedded applications.

A wide range of numerical encodings at multiple bit depths are supported: 8-bit and 16-bit formats, as well as additional specialized packed bit formats, are supported for both lossy and lossless compression. (32-bit formats are supported using lossy compression.) Up to 24 bits are retained through the various transforms. While only integer arithmetic is used for internal processing, lossless and lossy coding are supported for floating point and fixed point image data – as well as for integer image formats.

The main body of this document specifies the syntax and semantics of JPEG XR coded images and the associated decoding process that produces an output image from a coded image. Annex A specifies a tag-based file storage format for storage and interchange of such coded images. Annex B specifies profiles and levels, which determine conformance requirements for classes of encoders and decoders. Aspects of colour imagery representations and colour management are discussed in Annex C. The typical expected encoding process is described in Annex D. Annex E contains a media type specification for images encoded according to the tag-based format specified in Annex A for use in various internet protocols. Annex F specifies an alternative file storage format based on

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ISO/IEC 23008-12 and associated media type specifications for the storage and interchange of JPEG XR coded images and image sequences. Annexes A, B, E, and F are an integral part of this document and contain normative specifications.

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of patents.

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Information technology — JPEG XR image coding system —

Part 2:
Image coding specification

1 Scope

This document specifies a coding format, referred to as JPEG XR, which is designed primarily for continuous-tone photographic content.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Rec. ITU-T T.833 | ISO/IEC 29199-3, *Information technology — JPEG XR image coding system — Part 3: Motion JPEG XR*

ISO/IEC/IEEE 60559, *Information technology — Microprocessor systems — Floating-Point arithmetic*

ISO/IEC 10646:2017, *Information technology — Universal coded character set (UCS)*

ISO/IEC 23008-12:2017, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 12: Image file format*

3 Terms and definitions

For the purposes of this document, the terms, definitions and abbreviated terms specified in ISO/IEC 23008-12 and the following apply.

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

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

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

NOTE For the avoidance of doubt, in case of ambiguities, the definitions in this document take precedence over the definitions of ISO/IEC 23008-12 except in regard to the file format specified in Annex F. A sample in the context of ISO/IEC 23008-12 and in Annex F is "all the data associated with a single time". In Annex G, this is meant as all data associated with one coded image, not "element in a two-dimensional image array that comprises an image plane".

3.1
adaptive coefficient normalization
parsing sub-process where *transform coefficients* (3.75) are dynamically partitioned into a *VLC*-coded (3.77) part and a *fixed-length coded* (3.28) part, in a manner designed to control (i.e., "normalize") bits used to represent the VLC-coded part

Note 1 to entry: The fixed-length coded part of DC coefficients and low-pass coefficients is called FLC refinement and the fixed-length coded part of high-pass coefficients is called flexbits.

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