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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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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.

ISO/IEC 29199-2 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.

This part of ISO/IEC 29199 is technically aligned with ITU-T Rec. T.832 but is not published as identical text.

This third edition cancels and replaces the second edition (ISO/IEC 29199-2:2010), which has been technically revised.

ISO/IEC 29199 consists of the following parts, under the general title *Information technology — JPEG XR image coding system*:

— *Part 1: System architecture* [Technical Report]

— *Part 2: Image coding specification*

— *Part 3: Motion JPEG XR*

— *Part 4: Conformance testing*

— *Part 5: Reference software*

Introduction

This part of ISO/IEC 29199 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 color 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 color values).

More demanding applications may require a bit depth of 16, providing 65 536 representable values for each channel, and resulting in over $2.8 * 10^{14}$ color 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 color 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.

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 color types by converting these color formats to an internal luma-dominant format through the use of a reversible color transform. In addition, YUV, monochrome and arbitrary n-channel color 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 part of ISO/IEC 29199 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 color imagery representations and color management are discussed in Annex C. The typical expected encoding process is described in Annex D.

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.

ISO and IEC take no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured ISO and IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statements of the holders of these patent rights are registered with ISO and IEC. Information may be obtained from the companies listed in Annex E.

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

Information technology — JPEG XR image coding system —

Part 2: Image coding specification

1 Scope

This part of ISO/IEC 29199 specifies a coding format, referred to as JPEG XR, which is designed primarily for continuous-tone photographic content.

2 Normative references

Normative references having a scope that is limited to the use of the file format specified in Annex A are listed in A.2.

3 Terms and definitions

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

NOTE Definitions of terms having a scope that is limited to the use of the **file format** specified in Annex A are listed in A.2.

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

NOTE 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**.

3.2
adaptive inverse scanning
parsing sub-process where the **zigzag scan order** associated with a set of **transform coefficients** is dynamically modified, based on the statistics of previously-parsed **transform coefficients**

3.3
adaptive VLC
parsing sub-process where the code table associated with **VLC** parsing of a particular **syntax element** is switched, among a finite set of fixed tables, based on the statistics of previously-parsed instances of this syntax element

3.4
alpha image plane
optional secondary image plane associated with an image of the same dimensions as the luma component of the primary image plane

NOTE The alpha image plane has one component, a luma component.

3.5
block
m×n array of **samples**, or an m×n array of **transform coefficients**