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Information technology — Scalable compression and coding of continuous-tone still images —

Part 2: Coding of high dynamic range images

Technologies de l'information — Compression échelonnable et codage d'images plates en ton continu —

Partie 2: Codage d'images à gamme dynamique élevée

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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.

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).

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For an explanation on 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.

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

A list of all parts in the ISO 18477 series, published under the general title *Information technology -- Scalable compression and coding of continuous-tone still images*, can be found on the ISO website.

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Introduction

This document is an extension of ISO/IEC 18477-1, a compression system for continuous tone digital still images which is backward compatible with Rec. ITU-T T.81 | ISO/IEC 10918-1. That is, legacy applications conforming to Rec. ITU-T T.81 | ISO/IEC 10918-1 will be able to reconstruct streams generated by an encoder conforming to this document, but will possibly not be able to reconstruct such streams in full dynamic range, full quality or other features defined in this document.

The aim of this document is to provide a migration path for legacy applications to support coding of high-dynamic range images. Existing tools depending on the existing standards will continue to work, but will only be able to reconstruct a lossy and/or a low-dynamic range version of the image contained in the codestream. This document specifies a codestream, referred to as JPEG XT, which is designed primarily for storage and interchange of continuous-tone photographic content.

This document specifies a coded codestream format for storage of continuous-tone high and low dynamic range photographic content. JPEG XT Part 2 is a scalable image coding system supporting multiple component images in floating point. It is by itself an extension of the coding tools defined in ISO/IEC 18477-1; the codestream is composed in such a way that legacy applications conforming to Rec. ITU-T T.81 | ISO/IEC 10918-1 are able to reconstruct a lower quality, low dynamic range, eight bits per sample version of the image.

Today, the most widely used digital photography format, a minimal implementation of JPEG (specified in Rec. ITU-T T.81 | ISO/IEC 10918-1), uses a bit depth of 8; each of the three channels that together compose an image pixel is represented by 8 bits, providing 256 representable values per channel. For more demanding applications, it is not uncommon to use a bit depth of 16 or higher, providing greater than 65 536 representable values to describe each channel within a pixel, resulting on over 2.8×10^{14} representable colour values. In some less common scenarios, even greater bit depths are used.

The most common photo and image formats use an 8-bit or 16-bit unsigned integer value to represent some function of the intensity of each colour channel. While it might be theoretically possible to agree on one method for assigning specific numerical values to real world colours, doing so is not practical. Since any specific device has its own limited range for colour reproduction, the device's range may be a small portion of the agreed-upon universal colour range. As a result, such an approach is an extremely inefficient use of the available numerical values, especially when using only 8 bits (or 256 unique values) per channel. To represent pixel values as efficiently as possible, devices use a numeric encoding optimized for their own range of possible colours or gamut.

JPEG XT is primarily designed to provide coded data containing high dynamic range and wide colour gamut content while simultaneously providing 8 bits per pixel low dynamic range images using tools defined in ISO/IEC 18477-1. The goal is to provide a backward compatible coding specification that allows legacy applications and existing toolchains to continue to operate on codestreams conforming to this this document.

JPEG XT has been designed to be backward compatible to legacy applications while at the same time having a small coding complexity; JPEG XT uses, whenever possible, functional blocks of Rec. ITU-T T.81 | ISO/IEC 10918-1 to extend the functionality of the legacy JPEG Coding System. It is optimized for storage and transmission of high dynamic range and wide colour gamut 32 bit float images while also enabling low-complexity encoder and decoder implementations.

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Information technology — Scalable compression and coding of continuous-tone still images —

Part 2:
Coding of high dynamic range images

1 Scope

This document specifies a coding format, referred to as JPEG XT, 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.

ISO/IEC 10918-1, *Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines — Part 1*

ISO/IEC 18477-1, *Information technology — Scalable Compression and Coding of Continuous-Tone Still Images, Core Coding System Specification*

IEC 61966-2-1, *sRGB Colour management — Default RGB colour space — sRGB*

3 Terms and definitions

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

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
ASCII encoding
character encoding scheme defined by ANSI X3.4-1986

3.2
codestream
partially encoded or decoded sequence of bits comprising an entropy-coded segment

3.3
byte
group of 8 bits

3.4
coder
embodiment of a coding process

3.5
coding
encoding or decoding

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3.6
(coding) process
general term for referring to an encoding process, a decoding process, or both

3.7
compression
reduction in the number of bits used to represent source image data

3.8
component
two-dimensional array of samples having the same designation in the output or display device

Note 1 to entry: An image typically consists of several components, e.g. red, green and blue.

3.9
continuous-tone image
image whose components have more than one bit per sample

3.10
discrete cosine transform
DCT
sum of cosine transforms at different frequencies

3.11
decoder
embodiment of a decoding process

3.12
decoding process
process which takes as its input compressed image data and outputs a continuous-tone image

3.13
downsampling
procedure by which the spatial resolution of a component is reduced

3.14
encoder
embodiment of an encoding process

3.15
encoding process
process which takes as its input a continuous-tone image and outputs compressed image data

3.16
grayscale image
continuous-tone image that has only one component

3.17
high dynamic range
image or image data comprised of more than eight bits per sample

3.18
Joint Photographic Experts Group
JPEG
informal name of the working group which created this part of ISO/IEC 18477

Note 1 to entry: The term “joint” comes from the ITU-T and ISO/IEC collaboration.

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3.19
legacy decoder
embodiment of a decoding process conforming to Rec. ITU-T T.81 | ISO/IEC 10918-1, confined to the lossy discrete cosine transformation (DCT) process and the baseline, sequential or progressive modes, decoding at most four components to eight bits per component

3.20
lossless
descriptive term for encoding and decoding processes and procedures in which the output of the decoding procedure(s) is identical to the input of the encoding procedure(s)

3.21
lossless coding
mode of operation which refers to any one of the coding processes defined in this part of ISO/IEC 18477 in which all of the procedures are lossless

3.22
lossy
descriptive term for encoding and decoding processes which are not lossless

3.23
low-dynamic range
image or image data comprised of data with no more than 8 bits per sample

3.24
marker
two-byte code in which the first byte is hexadecimal FF and the second byte is a value between 1 and hexadecimal FE

3.25
marker segment
marker together with its associated set of parameters

3.26
minimum coded unit
MCU
smallest group of data units that is coded

3.27
pixel
collection of sample values in the spatial image domain having all the same sample coordinates

Note 1 to entry: A pixel may consist of three samples describing its red, green and blue value.

3.28
precision
number of bits allocated to a particular sample or discrete cosine transformation (DCT) coefficient

3.29
procedure
set of steps which accomplishes one of the tasks which comprise an encoding or decoding process

3.30
residual codestream
codestream that contains an encoded (according to Rec. ITU-T T.81 | ISO/IEC 10918-1) residual image

3.31
residual data
data that contains luminance ratio and red, green, and blue (RGB) differential data

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3.32
residual image
pseudo image that contains encoded luminance ratio as luminance and encoded chrominance data that is computed from red, green, and blue (RGB) differential data using Multiple Component Decorrelation Transformation defined in ISO/IEC 18477-1

3.33
red, green, and blue
RGB
additive colour model

3.34
luminance ratio
array of per pixel ratio of HDR image luminance and LDR image luminance

3.35
quantization value
integer value used in the quantization procedure

3.36
quantize
act of performing the quantization procedure for a value

3.37
upsampling
procedure by which the spatial resolution of a component is increased

4 Abbreviated terms and symbols

4.1 Abbreviated terms

ASCII	American Standard Code for Information Interchange
HDR	High Dynamic Range
LDR	Low Dynamic Range

4.2 Symbols

Nc	number of components in an image

5 Conventions

5.1 Conformance language

The keyword “reserved” indicates a provision that is not specified at this time, shall not be used, and may be specified in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be specified in the future.

5.2 Operators

NOTE Many of the operators used in this document are similar to those used in the C programming language.

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