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Part 15: Signalling, backward compatibility and display adaptation for HDR/WCG video

Technologies de l'information — Codage à haut rendement et fourniture de supports dans les environnements hétérogènes —

Partie 15: Signalisation, compatibilité amont et adaptation de l'affichage pour la vidéo HDR/WCG

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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).

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This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. A technically aligned twin text is published as ITU-T H.Sup18.

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Introduction

High dynamic range (HDR) video is a type of video content in which the sample values represent a larger luminance range than conventional standard dynamic range (SDR) video. HDR video can provide an enhanced viewer experience and can more accurately reproduce scenes that include, within the same image, dark areas and bright highlights, such as emissive light sources and reflections. Wide colour gamut (WCG) video, on the other hand, is video characterized by a wider spectrum of colours compared to what has been commonly available in conventional video. Recent advances in capture and display technology have enabled consumer distribution of HDR and WCG content. However, given the characteristics of such content, special considerations may need to be made, in terms of both processing and compression, compared to conventional content.

This document relates to HDR/WCG video coding and distribution, using single-layer or dual-layer coding, with the signalling specified for Rec. ITU-T H.265 | ISO/IEC 23008-2 High efficiency video coding (HEVC), and when applicable, Rec. ITU-T H.264 | ISO/IEC 14496-10 Advanced video coding (AVC).

This document serves several purposes:

— It provides a survey of identified video usability information (VUI) syntax elements and supplemental enhancement information (SEI) messages specified in HEVC and AVC applicable for HDR/WCG video.

— It covers conversion and coding chains using the IC_TC_P colour representation, and the hybrid log-gamma (HLG) transfer functions.

— Examples of using colour remapping information (CRI) and tone mapping information (TMI) SEI messages for the support of SDR backward compatibility and display adaptation functionalities are described.

— A dual-layer coding approach using the Scalable Main 10 profile of HEVC for backward compatibility with SDR systems is also documented.

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Information technology — High efficiency coding and media delivery in heterogeneous environments —

Part 15: Signalling, backward compatibility and display adaptation for HDR/WCG video

1 Scope

This document reviews approaches for processing and coding of HDR/WCG video content. The purpose of this document is to provide a set of publicly-referenceable methods for the operation of AVC or HEVC video coding systems adapted for compressing HDR/WCG video for consumer distribution applications.

This document first includes a review of the video usability information (VUI) indicators and supplemental enhancement information (SEI) messages applicable for HDR/WCG video. It provides a description of processing steps for converting from 4:4:4 RGB linear light representation video signals into video signals with IC_TC_P colour representation and perceptual quantizer (PQ) transfer function, or with Y′CbCr colour representation and HLG transfer function (IC_TC_P, PQ and HLG are defined in Rec. ITU-R BT.2100-1). Some high-level approaches for compressing these signals using either Rec. ITU-T H.264 | ISO/IEC 14496-10 or Rec. ITU-T H.265 | ISO/IEC 23008-2 are provided. A description of post-decoding processing steps is also included for converting back to a linear light, 4:4:4 RGB representation. The document also addresses the standard dynamic range (SDR) backward compatibility, that is, the compatibility with legacy decoding systems that are not able to detect and properly display HDR/WCG video content. It describes example implementations of this feature using three different solutions: using HLG as a backward compatible transfer function, using CRI and TMI SEI messages, using dual-layer approach with the Scalable Main 10 profile of HEVC and an SDR compatible base layer. Finally, the document illustrates the usage of CRI SEI messages to convey metadata enabling the dynamic range and colour gamut adaptation at the display side of the decoded video to the display capabilities.

NOTE The document complements the material provided in ITU-T H.Sup15 | ISO/IEC TR 23008-14, which is focused on conversion and coding practices for non-constant luminance (NCL) Y′CbCr video signals using the PQ transfer function.

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.

Recommendation ITU-T H.264 | ISO/IEC 14496-10: 2014, *Information technology — Coding of audio-visual objects — Part 10: Advanced Video Coding*

Recommendation ITU-T H.265 | ISO/IEC 23008-2: 2017, *Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in Rec. ITU-T H.264 | ISO/IEC 14496-10, Rec. ITU-T H.265 | ISO/IEC 23008-2, and the following apply.

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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 https://www.iso.org/obp

3.1
dynamic range adaptation
DRA
mapping process to convert content from one colour volume to another colour volume

3.2
electro-optical transfer function
EOTF
function which converts a non-linear video signal into a quantity of output linear light

Note 1 to entry: An example of output linear light is light emitted by a display.

3.3
full range
range in a fixed-point (integer) representation that spans the full range of values that could be expressed with that bit depth, such that, for 10-bit signals, black corresponds to code value 0 and peak white corresponds to code value 1023 for Y′

Note 1 to entry: As per the full range definition from Rec. ITU-R BT.2100-1.

3.4
hybrid log-gamma
HLG
one set of transfer functions offering a degree of compatibility with legacy displays by more closely matching the previously established television transfer curves

Note 1 to entry: Sets of transfer functions related to HDR signals are specified in Rec. ITU-R BT.2100-1.

3.5
narrow range
range in a fixed-point (integer) representation that does not span the full range of values that could be expressed with that bit depth such that, for 10-bit representations, the range from 64 (black) to 940 (peak white) is used for Y′ and the range from 64 to 960 is used for Cb and Cr

Note 1 to entry: As per the narrow range definition from Rec. ITU-R BT.2100-1.

3.6
opto-electronic transfer function
OETF
function which converts a source input linear optical intensity into a non-linear video signal

Note 1 to entry: An example of input linear optical intensity is light input to a camera.

3.7
opto-optical transfer function
OOTF
function which has the role of applying the “rendering intent” on video signal

Note 1 to entry: In general, an OOTF is a concatenation of an OETF, artistic adjustments and an EOTF.

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3.8
perceptual quantizer
PQ
one set of transfer functions achieving a very wide range of brightness levels for a given bit depth using a non-linear transfer function that is finely tuned to match the human visual system

Note 1 to entry: Sets of transfer functions related to HDR signals are specified in Rec. ITU-R BT.2100-1.

3.9
random access point access unit
RAPAU
access unit in the bitstream at which the initiation of the decoding process for some or all subsequent pictures in the bitstream is intended to be feasible

3.10
reference electro-optical transfer function
reference EOTF
specified EOTF for use under specific viewing environment, named the reference viewing environment

3.11
reference opto-electronic transfer function
reference OETF
specified OETF implemented within cameras, to ensure consistency of the image between cameras from different manufacturers

3.12
reference viewing environment
parameters to establish a reproducible viewing environment for critical viewing of material that can provide repeatable results from one facility to another when viewing the same material

Note 1 to entry: Rec. ITU-R BT.2100-1:2017, Table 3 provides reference viewing environment parameters for HDR programme material.

4 Abbreviated terms

For the purposes of this document, the abbreviated terms given in Rec. ITU-T H.264 | ISO/IEC 14496-10, Rec. ITU-T H.265 | ISO/IEC 23008-2 and the following apply.

ATC alternative transfer characteristics

AVC advanced video coding, specified in Rec. ITU-T H.264 | ISO/IEC 14496-10

AVE ambient viewing environment

CGS colour gamut scalability

CI constant intensity

CL constant luminance

CLL content light level

CLVS coded layer-wise video sequence

CRI colour remapping information

FIR finite impulse response

HDR high dynamic range

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