

JCTVC-P0159

High Dynamic Range video coding

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Purpose of the contribution

Description of an HDR video coding scheme

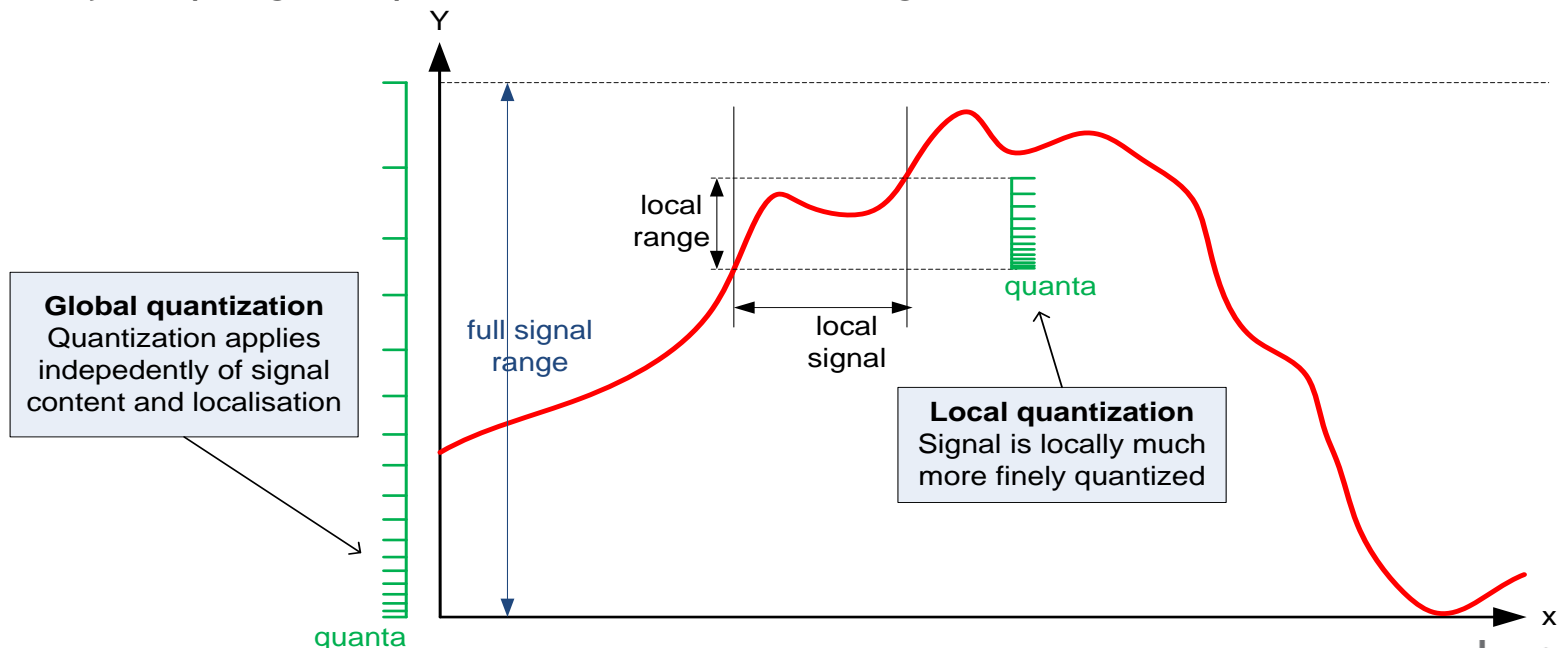
The proposed scheme has the following characteristics

- Re-use of a low bit-depth decoder
 - e.g. AVC 8-bit, HEVC 8- or 10-bit
- Usage of HDR-related side information
- Generic technology, that can be potentially backward compatible with LDR devices
 - Low bit-depth Decoders and LDR Displays
- High compression performance

Principles of the proposed solution

HDR signal is locally of low dynamic range (LDR localization)

- HDR signal split into 2 LDR signals with limited bit-depth (e.g. 8 or 10 bits)
 - Low frequency signal: local luminance signal mean
 - Residual signal: locally LDR signal made of the remaining high frequency signal
- The signal decomposition enables
 - keeping a very high signal precision
 - finely adapting the quantization to the local signal characteristics



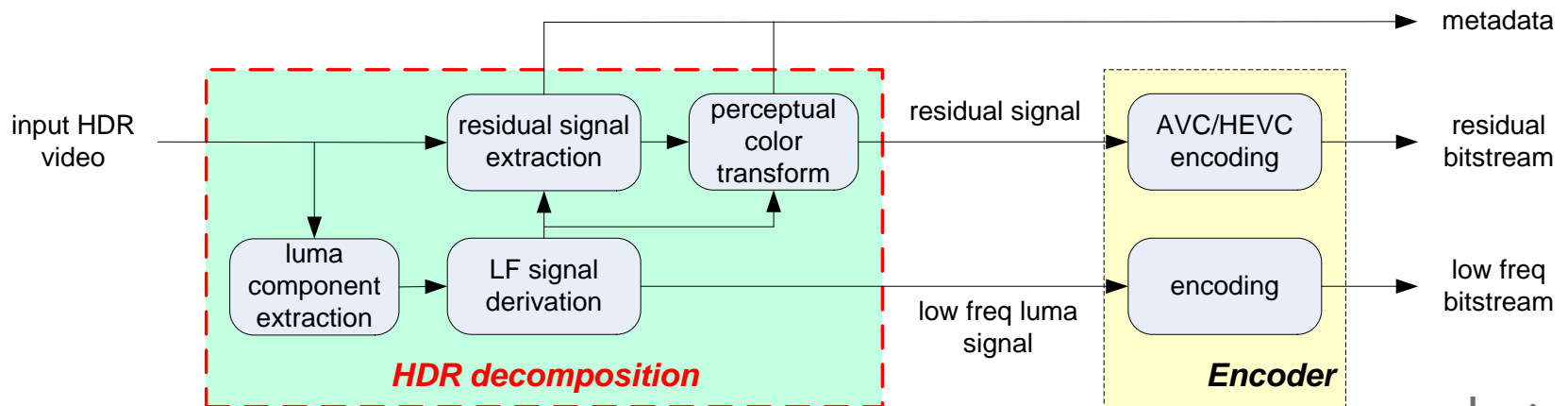
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Generic encoding scheme (1/2)

HDR signal decomposition

- Extraction of luminance component from the input HDR signal
- Extraction of low frequency signal from luminance component
 - can be significantly lower than the input signal resolution
- Extraction of residual signal from luminance component
 - based on a demodulation of the HDR signal by the low frequency signal
- Perceptual color transform
 - perceptually preserving the signal characteristics and variations
 - can also take into account local signal properties



Generic encoding scheme (2/2)

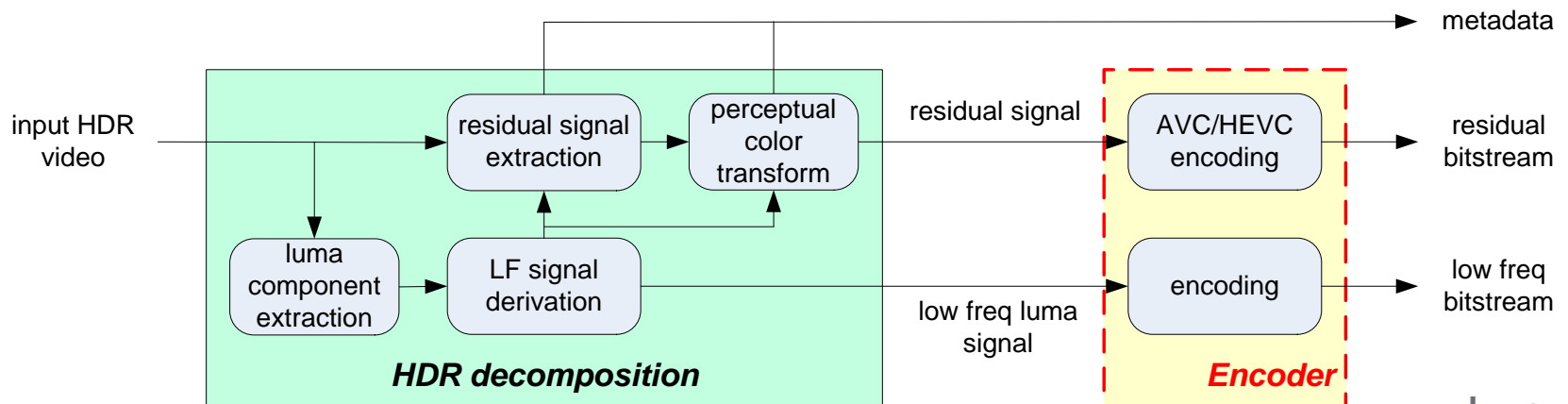
LDR signals encoding

■ Residual signal encoding

- same resolution as the native HDR signal
- using an existing limited bit-depth encoder, such as AVC 8-bit, HEVC 8- or 10-bit.

■ Low frequency signal encoding

- by nature of very low entropy → reduced resolution, very low coding cost



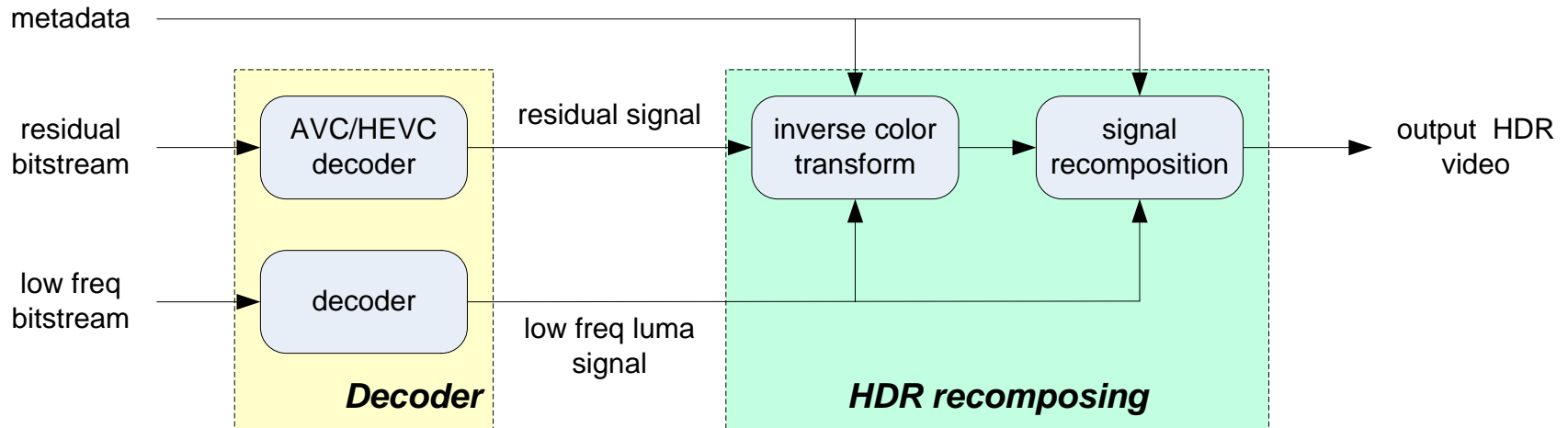
Generic decoding scheme

Decoding of LDR signals

- Using low bit-depth decoders (e.g. AVC-8 bit, HEVC 8- or 10-bit)

HDR signal recomposing

- Inverse color transform applied to decoded residual signal
- Modulation of resulting signal by low frequency signal



Specific design based on backlighting + LDR residual

1/2

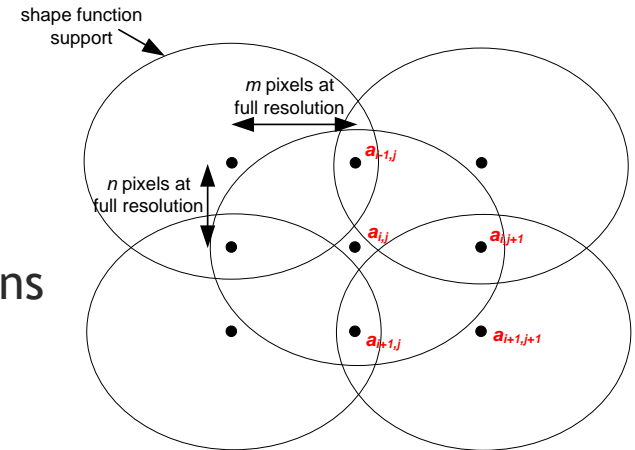
Idea

- directly exploit the design of existing HDR displays, based on the modulation of an **LDR picture** by a LED **backlighting**
- viewable residual picture with an LDR display
 - kind of toned-mapped version of the HDR image which renders consistently compared to the original HDR scene

Low frequency signal derivation

- Backlight signal extraction
 - linear combination of overlapping shape functions

$$Ba[k, l] = \sum_{(i,j) \in V_{K,L}} a_{i,j} \psi_{i,j}[k - m.i, l - n.j]$$



- re-normalized in order to keep the brightness and temporal consistency of the residual signal with the original HDR signal → signal Ba'
- **Low frequency signal: weights array $a_{i,j}$**

Specific design based on backlighting + LDR residual

2/2

Residual signal extraction

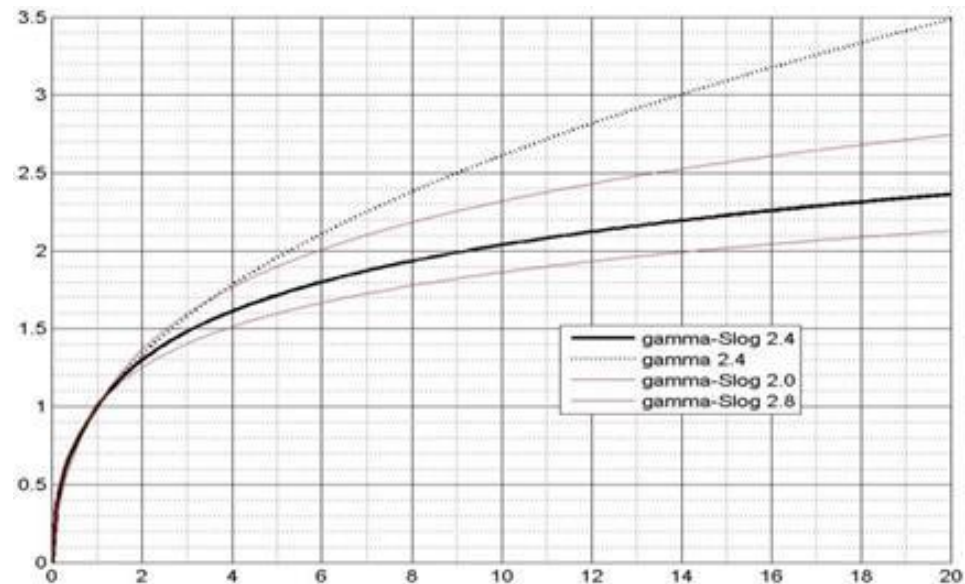
- demodulation of the HDR signal by the re-normalized backlight signal
 - $X_{res} = X / Ba'$ same for Y_{res} and Z_{res}

Perceptual color transform





- Gamma + S-log correction
 - to finely quantize the dark ranges while avoiding harsh high light saturations
- conversion to LDR on N bits

$$X_{LDR} = \max(2^N - 1, c_{scal} * X_{res})$$

same for Y_{LDR} and Z_{LDR}

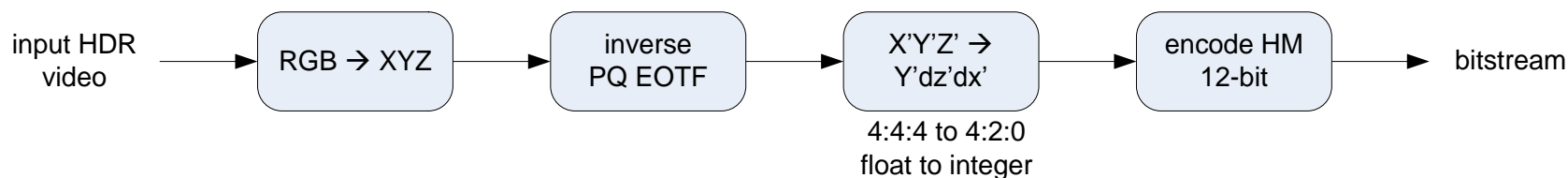


Experiments

Seine		1080p 25 fps	21 f-stops	Mostly dark with some bright spots Limited colors Static scene with slow motion
Balloon		1080p 30 fps	16 f-stops	Medium illumination Medium color spectrum Slow global and local motions
Market3		1080p 50 fps	15 f-stops	High illumination Wide color spectrum Static scene with slow motion
Fire-eater		1080p 25 fps	18 f-stops	Mostly dark with high luminance fires Limited colors Static scene with complex random motions

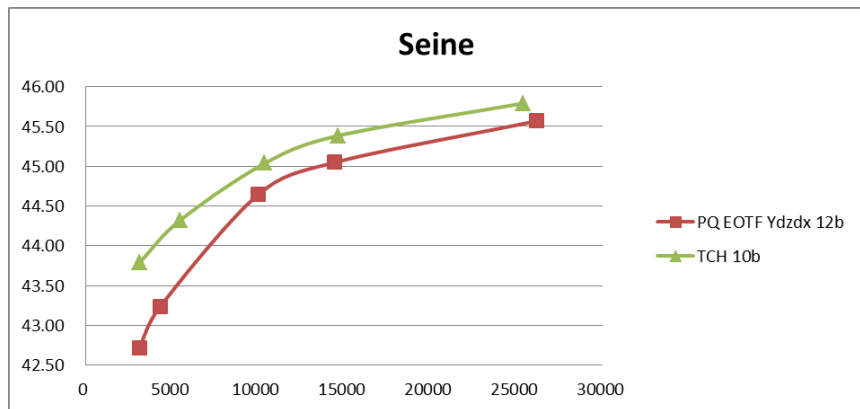
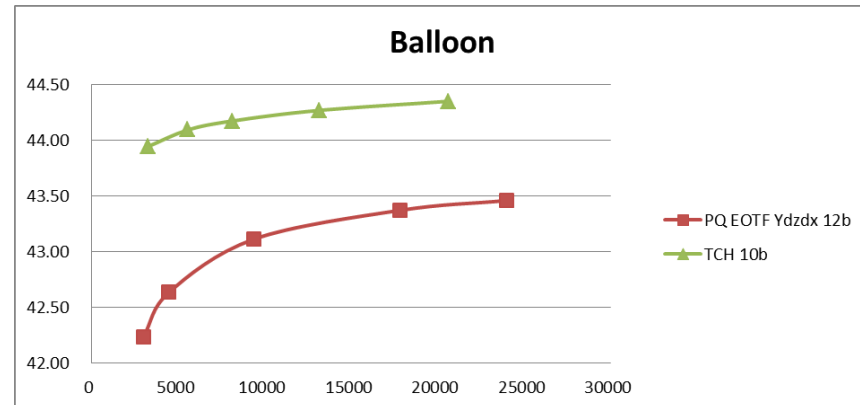
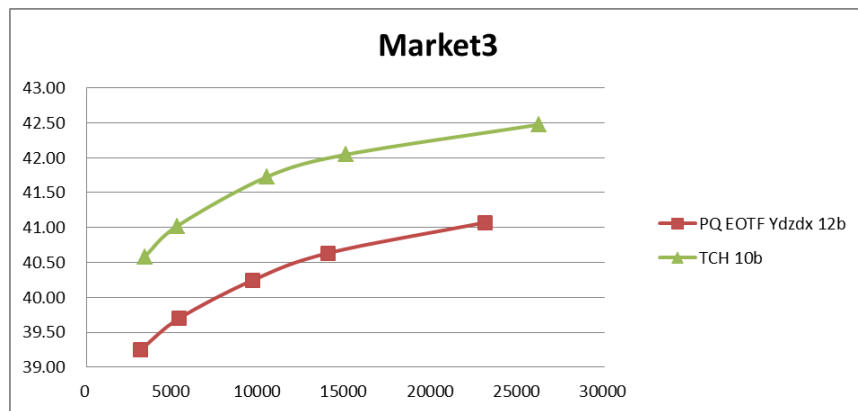
ΔE_{2000} PSNR as objective perf. measure $PSNR_{\Delta E} = 10 \cdot \log_{10} \left(\frac{65504}{\Delta E_{mean}} \right)$

Comparison with PQ EOTF / Yd zd x coding chain



Results

Visual comparisons will also be proposed in viewing sessions



Conclusions

A generic HDR coding scheme is proposed, with the following assets

- **Backward compatibility with LDR decoders:**

- enables re-using legacy low bit-depth decoder (AVC 8-bit, HEVC 8- or 10-bit)

- **Potential backward compatibility with LDR displays:**

- offers a potential backward compatibility with LDR displays (viewable LDR video)

- **High compression performance:**

- exploitation of the locally LDR property of the HDR signal,
- perceptually based color adaptation of the residual signal,
- fine quantization of the LDR signal.