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| *Title:* | **Evaluation of HDR 4:2:0 chroma subsampling methods** | | |
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| *Author(s) or Contact(s):* | Jacob Ström, Jonatan Samuelsson, Per Hermansson, Kenneth Andersson Färögatan 6 16480 Stockholm | Tel: Email: | +46107136883 [jacob.strom@ericsson.com](mailto:jacob.strom@ericsson.com) |
| *Source:* | Ericsson | | |

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# Abstract

This contribution investigates the relative merits of different target functions when doing luma adjustment. In particular, it investigates a claim whether the “algorithm 1”-method presented in W0107 improves the first frame of Market in 709 color container compared to the luma adjustment presented earlier that is based on luminance matching. In this contribution it is claimed that the “algorithm 1” method does not improve subjective quality over the iterative luma adjustment technique in this case and instead adds a small artifact not visible in the luminance matching based luma adjustment technique.

# Introduction

Prior to the MPEG Call for Evidence for HDR and WCG Video Coding [1] it was reported in several contributions [2], [3], [4] that there is a subjective quality problem with HDR Y’CbCr non-constant luminance 4:2:0 color format.

In [5] an iterative solution to the problem was proposed that finds the luma sample that result in a linear luminance that is closest to the original signal. In this document we will refer to this as iterative luminance matching luma adjustment or just luminance matching. A more detailed description to this method is given in [7].

In [6] a non-iterative solution is proposed that differs from previous method in two ways. First,, instead of optimizing luma for finding the linear luminance closest to the original, the error is minimized in linear RGB color space using a metric that weights together the distortion of the three R,G,B components. In the implementation equal weights are used,

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where is the original color and is the corrected color for a pixel. In comparison, the luminance matching method from [5] can be thought of as instead minimizing the error function

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which equals . The second idea is that luma values can be determined in a non-iterative way by a linear approximation of the EOTF. This was applied both to the new error function (“algorithm 1”) as well as luminance matching error function (“algorithm 2” form [6]).

In the contribution it was claimed that “algorithm 1” gave perceptually better results than the iterative luminance matching proposed in [5] for a particular part of the first frame of Market. In this document we are doing a cross check of that statement to see if it holds up on a SIM2 display.

# Subjective evaluation

A comparison between the luminance matching luma adjustment solution in [5] and “algorithm 1” from [6] has been performed using the algorithms made available in the latest version of the 0.11 development branch of HDRTools (2016-05-07). The Market sequence using the BT.709 container was selected and converted to Y’CbCr and subsampled to 4:2:0 using both methods. The result was then upsampled again without compression and converted to an .avi file using the HDRToolsSIM2 software for viewing on a SIM2 monitor. An informal subjective viewing was then performed on the SIM2 monitor where both versions and the 4:4:4 original were shown one after each other.

First we looked at the first frame in normal resolution (full frame). When looking at the picture regions reported in [6] it was noted that both the price tag and awning look identical to the original in both algorithms. This is in correspondence with what was reported in [6].

However, [6] also reported a chroma shift between the original and the luminance matching approach from [5] in the area shown in Figure 1. This was not visible in the viewing. In fact, it was very difficult to see any difference at all between the luminance matching approach from [5] and the 4:4:4 original even when toggling still frames back and forth. Instead, it was possible to see a difference between the original and “algorithm 1” from [6]. For “algorithm 1”, the red area is expanded to be slightly larger when compared to the original.

We also created zoomed-in versions of the relevant part of the first frame. This was done by first subsampling to create a .yuv file, then upsampling to create an .exr file (just as before). After this we cropped out a 480x270 area of the .exr file and pixel-replicated it (upsampled using nearest neighbor) to create a 1920x1080 image. This image was the fed through HDRToolsSIM2 to produce an .avi file viewable on the SIM2 monitor.

Now when comparing the zoomed-in 4:4:4 original with the zoomed-in luminance matching version from [5], we could see a small difference. However, when comparing the zoomed-in original with the zoomed-in image from algorithm 1 from [6], the difference was clearly larger.

It should be noted that even the difference between algorithm 1 from [6] and the original that we observed is not big. At the same time, we cannot find any evidence that algorithm 1 improves over the luminance matching version from [5] on this material. In fact, since the difference between [5] and the original is so small, it seems very difficult to improve over [5] at least in this particular area.



Figure 1 Region investigated

# Conclusions

In summary, we cannot find any support for the claim that algorithm 1 from [6] produces less artifacts than the luminance matching luma adjustment approach from [5]. In fact we have seen the opposite, that the artifacts are bigger with algorithm1. Still, those artifacts are not large and seen as a whole, algorithm 1 from [6] certainly produces better quality images than the anchor processing chain.

# References

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