HVS Model-Based Tone Mapping Technique for Displaying HDR10 Contents

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The market for ultra-high-definition (UHD) TVs has been rapidly expanding due to the recent expansion of high-definition content produced and UHD broadcasting. UHD broadcasting supports high dynamic range (HDR) image content, which can represent a wider dynamic range than standard dynamic range (SDR) content for a more realistic experience. In particular, the HDR10 format, which is used in UHD broadcasting, can represent a luminance of up to 4,000 cd/m^2 (nit) using 10-bit color depth [1]. However, an SDR TV can display contents with lower dynamic range than that defined in HDR10. Moreover, as the peak luminance represented by each device is different, TVs that support HDR10 contents display them differently. Therefore, when HDR10 content is displayed on the SDR device or when the maximum luminance values of the HDR content and the display are different, a process of converting the dynamic range of the input HDR content, called tone mapping, is required.

In this work, we propose a human visual system (HVS) model-based tone mapping technique for displaying HDR10 content to maintain the perceptual quality of the input content. To this end, we formulate an optimization problem to obtain a tone mapping curve (TMC) that maps the pixel values in the input image to the pixel values in the output image to maximize the perceptual similarity between the HDR10 content and the displayed tone-mapped image. Specifically, as HVS is more sensitive to local luminance differences than to absolute values [2], we first measure the perceptual information in the input HDR10 content using 2D histograms [3]. Next, the pixel values in the 2D histogram are converted to the corresponding luminance values using the peak luminance value of the device and the electro-optical transfer function (EOTF) [4]. Then, the total perceptual responses in an entire image for the TMC are measured using the HVS sensitivity model in [5] in the luminance domain. Finally, an optimization problem is formulated to minimize the perceptual differences between the input HDR10 content and the tone-mapped image on the target display.

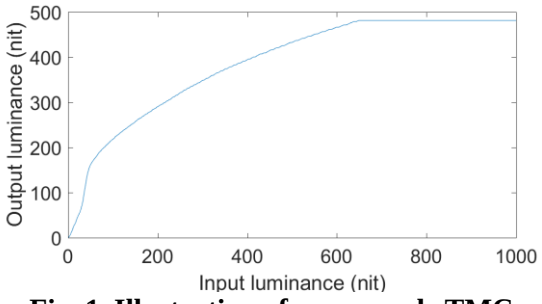

Fig. 1. Illustration of an example TMC.

Experimental results demonstrate that the proposed tone mapping algorithm preserves the perceptual differences between the input HDR10 content and tone-mapped image on real displays. Fig. 1 shows an example TMC when the peak luminance values of the HDR10 content and the display are 1,000 and 500 nits, respectively.

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