D3.4 NON REAL-TIME TONE MAPPING AND INVERSE TONE MAPPING IN A REFERENCE ENVIRONMENT

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1 EXECUTIVE SUMMARY

Cameras normally apply automatic non-linear transformations to the sensor data. These transformations allow for a perceptually-uniform quantization that is suited to standard dynamic range displays in dim conditions. The non-linearity or "tone mapping" (TM) applied in most digital cameras is well approximated by a simple power law, and while this may perform well on average, in general when dealing with high dynamic range scenes it is suboptimal. In the cinema industry, camera sensor data is recorded in raw (linear with respect to light intensity) form and is later non-linearly corrected by a skilled technician in post-production to optimize image appearance for cinema (dark) conditions. The literature provides a number of image-dependent automatic and semi-automatic non-linearities, some based on models of the human visual system. Additionally, there are more complex, local tone mapping algorithms that could, in theory, transform the sensor data, but these tend to be computationally more expensive, sensitive to image fluctuations, and harder to tune for specific applications. As a result, manual contrast grading is always preferred in professional cinema.

Inverse Tone Mapping (ITM) is the problem of expanding the dynamic range (DR) of a standard DR (SDR) image or video sequence, so that when shown in a HDR display it presents an enhanced contrast and color appearance but at the same time the viewing intent present in the original is respected. It is a challenging problem because the contrast increase inherent to the ITM process may make more visible the noise and quantization artifacts that are present in the SDR source (often of lower bit depth than the HDR output), diffuse white objects have to be distinguished from highlights even though they have similar numerical values in the SDR image, and real-time implementations must reach a compromise between speed an quality of the results.

In this document we report our initial work on developing non-real-time TM and ITM algorithms. For TM we propose a low-complexity algorithm that modifies the method we introduced in [1]: working in the IPT colorspace, and performing contrast-enhancement in a different manner in the luminance and the chrominance channels. The method is based on vision models and natural image statistics. Results look natural, with no artifacts, and visual quality is further improved with respect to [1]; results are shown to be the state-of-the-art according to user validation through psychophysical tests. For ITM results are still preliminary, we are developing two methods, one based on a variational model and the other on inverting a TM curve while imposing the preservation of the median luminance. For the latter method results are very promising but more extensive testing needs to be performed.