REAL TIME DELIVERY OF HDR VIDEO

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Abstract

High Dynamic Range (HDR) video provides a step change in viewing experience, for example the ability to clearly see the football when it is kicked from the shadow of the stadium into sunshine. To achieve the full potential of HDR video, so-called trueHDR, it is crucial that all the dynamic range that was captured or generated is delivered to the display device and tone mapping does not occur anywhere in the pipeline prior to the display. This paper describes a system of encoding and delivering HDR video which enables us to send video with a greater dynamic range than existing solutions from an HDR source (such as an HDR-enabled camera) to any display, including mobile devices, where it can be manipulated in real-time.

1 Introduction

HDR video enables the full range of lighting in a real world scene to be captured, stored, transmitted and displayed. To fully achieve this it is necessary to use 32 bit full-float to represent each colour channel; ie 96 bits per pixel. A single frame of raw HDR video at full High Definition (1920×1080) resolution is thus 24 Mbytes and a minute of footage 42GBytes (compared to just 10 GBytes for a minute of traditional video footage). This is larger than can be handled easily on existing ICT infrastructure. The use of HDR video thus requires new approaches at all stages of the pipeline.

2 HDR video compression

Several proposed HDR video solutions use a division of the HDR frame into multiple parts to preserve either backwards compatibility or to leverage existing technology for video compression [1]. In our encoder a stream of HDR video frames is split into a highly compressible base frame and detail frame containing the finer details of the original frame [2]. Both the base and detail frames are temporally compressed with a standard video encoder and are thus able to be processed, transmitted and received using existing architecture. The decoder-player takes advantage of the existing hardware decoders including those in iOS and Android devices, giving a significant existing base of hardware compatibility. The encoder is written in C++ and OpenCL, is implemented on multiple platforms, and takes advantage of the parallelism of modern multi-core CPUs and GPUs in a straightforward manner.

3 Full HDR Display

Compressing HDR video as it is captured by an HDR video system or generated by, eg. CGI, enables the full dynamic range to be kept and preserved along the entire pipeline to display using existing bandwidth. Most current solutions tone map the HDR video content prior to it reaching the display, eg. at the point of capture, or after post production. Tone mapping, however, is a “one way process”. Once tone mapped, any detail that was lost in the process may not subsequently be recovered. By compressing, rather than tone mapping, means that the full dynamic range is available at the display. This provides great flexibility, including direct display on an HDR screen, and, on an LDR display, the ability to dynamically alter the tone mapping to suit the current scene, creative intent and ambient light conditions, or investigate different parts of the scene with a choice of exposure. For example, in a live stream such as a sports broadcast, users can highlight areas of interest and maintain them at a clearly visible exposure allowing them to keep an eye on a particular player at the selected exposure level, even as the action takes place around the sun-lit goal.

4 Results

The software encoder is capable of achieving a rate of over 30 frames per second for a wide range of 720p HDR video footage, including computer generated HDR animations, such as those used in online gaming, Table 1.

	No. frames/ Resolution	Uncompr.	Compress.	Ratio	Encoding fps
Wedding	900/ 720p	10.0 GB	45 MB	222:1	33.58
Surgery	1302/ 720p	14.4 GB	63 MB	228:1	44.73
Morgan L	1375/ 720p	15.2 GB	65 MB	234:1	37.75
Kalabsha	720/ 1024x765	6.8 GB	36 MB	189:1	49.08
Makeup	518/ 1080p	12.9 GB	26 MB	496:1	19.81

Table 1: Compression ratios and performance

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References

[1] Banterle et al. “Advanced High Dynamic Range Imaging”, AKPeters, 2011.

[2] “HDR video data compression devices and methods”, European Patent no. 2144444.