HDR Video

Overview about Opportunities for Capturing and Usage in Digital Movie and TV Production

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Abstract

In a real-world scene, the dynamic range of illumination is higher than a normal DV, HD or movie camera is able to capture. With conventional methods, it is impossible to record scenes with difficult lightning in a satisfactory manner, for example an indoor-interview with a visible outdoor area illuminated by sunlight. Without HDR (High Dynamic Range) video, the parts outdoor will be overexposed or the inner area will be underexposed and after all the result leads to a compromise in these parts. Only for a couple of years companies and academic institutes have started research and development on capture and processing HDR video for cinema and broadcast. Among the advantage of making the capturing easier, it also improves realism and helps with a lot of scenarios in post-production. This paper describes and examines the different opportunities, assets and drawbacks for the creation of HDR video and analyzes their suitability for cinema and TV production.

For one it can be established that HDR cameras will be prepared with a high quality chip or with a set of different exposed chips, which are connected with a beam splitter. Solutions with sensors which take diverse exposures at different times or special camera-rigs will not come out on top due to inferior quality and non-practicable efforts, despite their ability to produce at lower costs at the moment. Furthermore, the author concludes that due to the improvements of video technologies and processing power HDR will be standard in the near future.

1 Introduction

With a standard video camera it is not possible to capture the whole dynamic range of a real world scene. Outdoor sunlight has a dynamic range of about 100,000:1 but an average digital camera is only able of 200:1. The human eye with the ability of long-term adaption can handle a range about 1.000.000:1 (cf. McCollough 2008: 14). It can easily be seen that the demand for realistic video capturing is given.

For a couple of years scientists and camera manufacturers have tried to set up a video system to capture a higher dynamic range than a normal video camera is capable of. But the idea of High Dynamic Range (HDR) is much older than supposed. The French photographer Gustave Le Gray (1820–1884) was the first person who combined several different exposed negatives to one photo to capture the whole dynamic range of the scene.

Figure 1 The Great Wave, Séte (Le Gray 1857)[1]

Meanwhile, since the appearance of digital photo cameras, HDR photography is widely common by professional and amateur photographers. Digital HDR photos can be achieved by the same principle as Le Gray invented in the 19th century. Several different exposures have to be combined in post-production to one HDR image. HDR is an inherent part in post-production, especially in rendering (CGI) and compositing. The latest achievements in

1 original: Metropolitan Museum of Arts, New York

the development of HDR video are the results of the rising of professional digital video cameras and the continuing increase of computing power.

One of the biggest problems is the presentation of HDR images. Common monitors, projectors and printers are not capable of displaying the whole dynamic range of a HDR image or HDR video. To watch a HDR video on television or on a computer screen, it has to be converted to a regular image via tone mapping. With this method, the high dynamic range, the bigger amounts of luminance and color depth are pressed into a common 8-bit file. But meanwhile some monitors, which are able to handle the big amount of data, are available for a special market. The most common devices are "Dual Modulation Displays" (also called "Local-Dimming Displays"). They use a separate backlight (LED) to provide the required luminance on the different exposed parts on an image. To play the HDR video files, there are HDR video players available, e.g from goHDR[2] or from XDepth[3]. For projectors there could be similar solutions, but for printers it is not possible to achieve an HDR image on ordinary paper, due to the limitations of the printing technology, which is based on the reflection of light. Due to this fact, there will be a demand for tone mapping algorithms always.

2 Method

This paper answers the question, if HDR video is needed and what are the use cases for this technology. Furthermore, it describes the possibilities to create HDR videos and compares the assets and drawbacks of the different approaches and defines the best solution for future developments.

3 Results

3.1 Usage of HDR video

To capture the full dynamic range of a real-world scene, there is a demand for HDR video systems. Otherwise, the camera operator has to make compromises in the composition of the picture. For example, if the inside of a room with a window should be perceptible, the window and everything outside will be overexposed.

2 goHDR: http://www.gohdr.com/products/ <2012-11-04>

3 XDepth: XDepth HDR Video Player: http://www.xdepth.com/XdepthVideoHDR/index.html <2012-07-03>

Figure 2 Overexposed outdoor-area

On the other hand, if the outdoor-area should be visible, all details in the room will be irrecoverably lost.

Figure 3 Underexposed indoor-area

With HDR video, such difficult light situations could be handled easily. It is possible to capture the details in and outside the room.

Figure 4 HDR video after local tone mapping

Video journalists or camera operators would profit from HDR video, because this opportunity solves an every-day problem and prevents compromises in image composition. The image would be more realistic and this is a nice add on for news features. In the wide field of post-production lots of improvements can be adopted. The HDR videos can be used for image based lightning, for compositing with CGI-content, for easier and more exact tracking, for color correction, for the creation and compositing of special effects and further more. To sum up, HDR video provides more data for post-production, which can be essential for a professional image.

3D productions can also benefit from this new technology. The realism will be far higher and this results in a better 3D experience for the audience.

HDR video will also provide a higher image quality for applications in science, medicine, surveillance and other fields of interest. Computer games are usually rendered in HDR, so it would be possible to provide a more realistic environment for the different setups. According to Akyüz, there will be a lot of improvements in the field of image processing algorithms due to the new software developments for HDR video (cf. Akyüz 2007: 9). Furthermore, HDR provides the real lightning information of a captured scene. This information can be stored in video archives for different capabilities. To sum up, HDR video is best solution for every project when more information is needed and when the camera operator has to deal with difficult light situations.

3.2 Technical Solutions for HDR Video Capture

There are several methods and technical setups available to capture HDR video. Analogue ones are not included.

Timelapse

Timelapse is one of the simplest and cheapest methods to create a HDR video. The video is done by a lot of single HDR photos, which were generated by a professional DSLR camera. Usually it's achieved with the bracketing function, which creates different exposed images. These images are combined in post to one HDR image. By shooting a lot of bracketed exposed pictures at a fixed interval, the video photographer can make HDR images in post-production and furthermore the video. This method is suitable for static scenes without action, due to the delay between the separate pictures.

Sequential Shooting

Another opportunity to get HDR video is to use a video camera instead of a photo camera. Similar to bracketing, the camera has to capture the scene

underexposed and overexposed to get a video with a higher dynamic range by combining the two streams in post-production. It is only useful in static or mechanical changeable scenes, because it is not possible to get exact similar movements in the scene with living objects. The advantage of this method are the cheaper costs, because a normal camera can be used.

Shooting HDR with a Rig

The next step in HDR video evolution is a method to use a modified 3D rig to record the same, only different exposed picture with two cameras. This can be achieved with a beamsplitter, who divides the light into two separate streams, which can be captured by different exposed cameras. The biggest difficulty is to synchronize the two cameras exactly, further disadvantages are the big camera settings and the doubling of the required resources. By using a cheap rig and cheaper cameras, HDR video can be achieved at very low costs compared with other solutions like HDR video cameras.

Chips and HDR Video Sensors

There are some sensors available that offer HDR video. Each approach is a little bit different. To sum up, a highly developed CMOS sensor usually provides a dynamic range about 120 dB or more. Not all of them are suitable for a cinema or TV production, but some of them are offering Full HD and providing an adequate quality for a professional use.

HDR Video Cameras

Nowadays, some systems are available that provide HDR video for the user. One of them is the RED Epic, which produces a dynamic range up to 18 EV (cf. Wilt 2010). The camera captures two streams, an overexposed and a normal one, which are combined in post-production or directly in the camera. With a resolution up to 5 K, it is qualified for productions for TV and cinema.

An other camera is the Spheron HDRv, which captures a dynamic range about 20 EV[4]. The max. resolution is limited by 1920×1080, which is enough for cinema and TV production these days. Four different exposed sensors inside the camera achieve the high dynamic range, but further technical details are not available for the public.

4 Spheron-VR AG: Spheron-Vr presents a first – live HDR Video sequence [press release]: http://www.spheron.com/media/news-press-releases/detail/spheron-vr-presents-a-first-live-action-hdr-video-sequence.html <2013-12-18>

A likewise project is the AMP Gen I (or AMP Gen II), which also use different exposed sensors to capture the light inside the camera. The dynamic range is about 17 EV, but the whole system is built modular (cf. Tocci et al. 2011: 6). This leads to the advantage that a better sensor can be used to get a higher dynamic range or to use some cheaper sensors for the consumer market.

There are other cameras available which offer HDR video, but they cannot provide the required quality for cinema or TV production. The trend is leading to HDR video, every notable camera producer is researching in better sensors or different solutions to provide HDR video.

Camera hacks

A further solution to get HDR video is provided by Magic Lantern, a free community who develops firmware upgrades for Canon DSLRs.[5] Their latest version includes a HDR video mode, which provides different exposed frames by changing the ISO settings for each frame. The different exposed frames can be combined in post-production, but this leads to a bisection of the frame rate. So it is only useful for static scenes or by videos with a double frame rate.

4 Conclusion

For one it can be established that HDR cameras will be prepared with a high quality chip or with a set of different exposed chips, which are connected by a beam splitter. Solutions with sensors which take diverse exposures at different times or special camera-rigs will not come out on top due to inferior quality and non-practicable efforts, despite their ability to produce at lower costs at the moment. Furthermore, the author concludes that due to the improvements of video technologies and processing power HDR will be standard in the near future.

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5 Magic Lantern: Release 2011-Dec-22: http://magiclantern.wikia.com/wiki/Release_2011Dec22 <2012-07-06>

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