

# A Review on High-dynamic-range imaging with its Technique

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**Abstract:** We presented a survey on High-dynamic-range imaging (HDRI or HDR) is a set of methods used in the imaging and photography to reproduce a superior dynamic range of luminosity than regular digital imaging or photographic methods can do. HDR images can denote a superior range of the luminance levels than can be attained using the extra 'classical' techniques. Images such as those holding many actual-world scenes, from same bright and direct sunlight to dangerous shade or very faint nebulae. It is the often succeeded in catching and then joining numerous dissimilar exposures of the similar subject matter. A Non-HDR cameras take a photograph with some limited amount of exposure range, as finally resulting in the damage of the detail in bright or dark parts. In this paper, we are studying about HDR image, generating of HDR image and also study about image fusion and methods of image fusing.

**Index Terms:** High-dynamic-range imaging, LDR, Fusion Technique.

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## I. INTRODUCTION

HDR images are the reproduction of scenes with a high range of luminance. More specifically, these scenes have a greater range of luminance than reflected or emitted from the reproduction media. This definition includes a great many scenes, because print and emissive display minima are controlled by their ambient surface reflections. Even if the display does not emit light at a pixel, the room light reflected from the surface of the display is that pixel minimal luminance. By fashioning several distinct exposure we can create HDR images. The term fusion in general means, an approach to extract information that is in several domains. The IF (image fusion) procedure is to the integrate multisensory or multi-view or multifocus knowledge into a novel image that holds superior quality of features and is the additional information of all the individual input knowledge. And The term quality, and also its meaning and measurement depend on the specific application. Image fusion is also known as Pan sharpening used to integrate the geometric details of high resolution (Panchromatic) images and color of little resolution or MS (multispectral) images. The resulting image holds a high resolution multispectral image.

In the history of HDR image In 1996 an arrival of the customer digital cameras formed a novel request for HDR imaging to increase the light reply of digital camera sensors, which had a greater lesser dynamic range than film. Steve Mann established and patented the global-HDR technique for creating digital images having a protracted dynamic range of the MIT Media Laboratory. Mann's technique elaborates a two-step process: (1) produce one floating point image array of globally-only image processors (processes that disturb every pixel identically, without regard to their local neighborhood's); and then (2) change this image array applying local neighborhoods processing (tone-remapping, etc.), into the HDR image. The image array produced by the first step in Mann's process is called a light space image, light space picture, or radiance map. Another advantage of global-HDR imaging is that it offers access to the intermediate light or radiance map, which has been used for computer vision,

and other image processing processes. In 1997, Debevec and Malik used multiple exposures and least-square fits to solve for the camera response function and the luminance of each pixel in the scene. Although some people have described its use of multiple exposures as revolutionary, In 2005 Photoshop CS2 presented the Merge to HDR purpose, 32 bit floating point image support for HDR images, and HDR tone mapping for a change of HDR images to LDR. [1]

HDR images can be obtained using either hardware or software methods. Hardware methods to capture HDR images include the use of multiple imaging devices, or devices with special sensors [2]. For example, Mitsunaga and Nayar describe the process of spatially varying pixel exposures [3]. They place an optical mask adjacent to a conventional image detector array. The mask has a pattern with spatially varying transmittance, thus adjacent pixels on the detector are given different exposures to the scene. Other methods use a different CCD design to achieve HDR imaging. For example, Wen [4] and Street [5] use a CCD camera where each detector cell includes two sensing elements of different size. This way, two measurements are made within each cell and are combined on-chip to produce an HDR image. Recently, Tublin et al. [6] Develop a new camera design that first measures the difference between adjacent pixel pairs and then quantizes the differences appropriately to capture an HDR image. Unfortunately, these devices are just beginning to enter the market and are so far expensive for mainstream consumers. Moreover, due to the limitations of digital image sensors, it is not generally possible to capture the full dynamic range of a scene with a single exposure [2]. The most common method for HDR image generation is based on the combination of multiple distinct exposures. The motivation behind this technique is that different exposures capture different dynamic range characteristics of the scene. For instance, bright regions are captured in the shorter exposures while dark regions are captured in the longer ones. Using pixel values, shutter times, and the camera response function, it is possible to estimate a scene-referred, high dynamic range radiance map that captures all details of the scene. However, this simple and easy to

implement technique suffers from two main problems: i) Misalignment: global camera motion, from a handheld camera, for instance, results in misaligned images that cause the combined HDR image to look blurry. ii) Ghosting: moving objects in the scene while capturing the images will appear in different locations in the combined HDR image, creating what are called ghost or ghosting artifacts.

## II. HIGH DYNAMIC RANGE IMAGING

The introduction of HDR imaging in the last two decades by the computer graphics community has revolutionized the field and other areas such as photography, virtual reality, visual effects, and the video-games industry. Physically correct light values can now be captured and fully utilized for various applications without the need to linearize the signal and to deal with clamped values. The very dark and bright areas of a scene can be recorded at the same time in an image or a video, avoiding under-exposed and over-exposed areas. Traditional imaging methods do not use physical values and typically are constrained by limitations in technology that could only handle 8-bit per color channel per pixel. Such imagery (8-bit or less per color channel) is referred as LDR imagery. This change in how light can be recorded is comparable to the introduction of color photography and has changed each stage of the imaging pipeline. The four main stages are: capturing, storing, processing, and displaying.[7]

### GENERATING OF HDR IMAGE

**Introduction** The two most common techniques for the generation of HDR panoramic images, mirror ball and panoramic [8], were assessed for ease of use and quality of the final image. Although the mirror ball technique has some advantages in terms of ease of use, as fewer shots are required, the relative complexity of software post-processing and difficulty in achieving good quality images makes the panoramic technique more suitable for this context. To reduce the relatively high number of shots required to create a 360° panorama this way a fisheye lens has been used. This limits the number of distinct sets of bracketed shots required to four. The immediate ground in the scene is missing (Figure 1), but for most lighting scenarios where the majority of lighting comes from the sky or more distant ground this has been considered an acceptable trade-off for simplicity. An additional consideration for the completion of the HDR generation workflow is the software required to composite the images taken into one HDR panorama. Fortunately the free, open-source and multiplatform photo Stitcher Hugin can natively composite and stitch bracketed shots into complete 360° HDR panoramas.

#### Final Set-up and Workflow

After investigation into different hardware and software options the following setup was chosen:

- Camera – Samsung gx-20 (up to 5 bracketed shots in 2EV steps)
- Lens - Samyang 8mm, spherical, fisheye lens
- Software - Hugin, open source, free and multiplatform panoramic Stitcher.

The camera delivers an 8EV range in the bracketed shots, which although still not high enough to capture the full brightness range between direct sunlight and darkness [9], visually comes quite close when rendering virtual scenes. The lens is a sphere, or full-frame, fisheye lens with a 180° corner to corner, 154° horizontal and 102° vertical (in landscape mode) field of view. To capture a full screen (excepting the floor beneath the camera which is not generally so important for lighting, and contains the camera tripod) the camera is tilted into portrait mode, tilted up 20° to capture the zenith and then 4 sets of bracketed shots are taken at 90° to each other. As the camera (in portrait mode) has a horizontal 102° field of view, these 4 sets of shots can just capture the whole 360° of horizontal view. The Hugin software is one of the few software programs that can generate HDR images (EXR format) and stitch them together into a panorama, or light probe, format. Hugin can export equirectangular projected images which equates to the poles, or late-long, light probe format (Figure 1). Most image stitching packages



Figure 1: Final tonemapped HDR panorama of an interior scene.

Work on the principle of finding common points in the overlapping portions of the images and using them to orientate the images with respect to each other, and this is also the case with Hugin. Another advantage of Hugin is that once the lens and camera combination has been calibrated, every subsequent stitching only requires a few control points. In an educational context where a student might only be producing a one-off HDR light probe, this simplification of the process is very advantageous. Calibration of the lens requires 20 to 30 overlapping shots to be taken within a large interior space (Figure 1). The space should be as large as possible and only control points at the scene periphery used, to minimize parallax errors from the slight movement of the lens as the camera is rotated. The scene should be interior to ensure the environment is static (e.g. No moving clouds), and that there are scene features to calibrate image overlap over the whole 360° panorama (unlike a clear blue sky). The free and multiplatform nature of the software also obviously has key benefits in a student user context, and in this regard is superior to the OS X only PhotoSphere, which has similar capabilities, or the multi-platform but commercial PTGui (which acts as a front end to the same tools as Hugin) and PhotoMatix. The overall cost of the system was approximately "900, which, although significant, should not be prohibitive for most educational institutions.

### III. IMAGE FUSION AND METHODS OF IMAGE FUSIONING

Image fusion is the process of combining information from two or more images of a scene into a single composite image that is more informative and is more suitable for visual perception or computer processing. The objective in image fusion is to reduce uncertainty and minimize redundancy in the output while maximizing relevant information particular to an application or task. Given the same set of input images, different fused images may be created depending on the specific application and what is considered relevant information. There are several benefits in using image fusion: wider spatial and temporal coverage, decreased uncertainty, improved reliability, and increased

Robustness of system performance. Often a single sensor cannot produce a complete representation of a scene. Visible images provide spectral and spatial details, and if a target has the same color and spatial characteristics as its background, it cannot be distinguished from the background. If visible images are fused with thermal images, a target that is warmer or colder than its background can be easily identified, even when its color and spatial details are similar to those of its background.[1] Fused images can provide information that sometimes cannot be observed in the individual input images. Successful image fusion significantly reduces the amount of data to be viewed or processed without significantly reducing the amount of relevant information.

Image fusion procedures can be largely categorized into the spatial domain and transform domain fusion Brovey technique, PCA (Principal Component analysis) intensity, hue, saturation (IHS) and High pass purifying procedures reduction in the spatial domain fusion methods. Spatial image fusion work by joining the pixel values of the two or more images. The humblest is averaging the pixel values of the input images wavelet transform and Laplacian transform come in the transform domain. In the transform domain technique the multi scale decomposition of the images is done and the composite image is built by applying the fusion rule. Then opposite multi scale transform is applied to accomplish the fused image.

#### *The multiple exposure fusioning technique*

High dynamic range images may be captured from real scenes are rendered by computer graphics techniques. The Most common approach to obtain an HDR image is to take multiple images of the same scene with different exposure times, and combine them into a single HDR image. The multiple exposure technique is based on the observation that taking multiple images with different exposures, each pixel will be properly exposed in at least one image. [1] There- fore, an HDR image is obtained by appropriately combining the LDR images. The fusion of a set of LDR images into an HDR image can be achieved in different methods which can be classified into two main approaches: fusion in the radiance domain and fusion in the image domain.

#### *Fusion in the radiance domain*

This HDR image generation method consists of three steps, **First**, The camera response function is recovered to bring the pixel brightness values into the radiance domain. This function models the effect of nonlinearities introduced in the image

acquisition process. Since the camera response function is not always provided by manufacturers, different methods are proposed for its estimation from a sequence of differently exposed images, **Second**, All radiance maps are combined into an HDR image encoded specially to store the pixel values that span the entire tonal range of the scene. **Third**, a tone mapping operator is used to make the HDR image display- able on common low dynamic range monitors, let  $\{L_k\} k=1 \dots N$  is a set of N images with exposure Given the camera response function  $f()$ , the HDR image is computed as the weighted average of pixel values across exposures using the following equation:

$$R_{uv} = \frac{\sum_{k=1}^n W(z_{uv}^k) f^{-1}(z_{uv}^k) / \Delta t_k}{\sum_{k=1}^n W(z_{uv}^k)}$$

Where R is the combined radiance map,  $z_{uv}^k$  is the pixel value at location(u, v) in exposure  $L_k$  and  $W(z_{uv}^k)$  is the weight of that pixel, The weighting function W () is designed to reduce the influence of unreliable pixels such as saturated ones. In order to display the obtained HDR image on a low dynamic range monitor, a tone mapping operator is applied. Tone mapping techniques can be categorized into local and global techniques. In global techniques specify one mapping curve that applies similarly to every pixels, while local methods provide a space-varying mapping curve that receipts into the account of the local content of the image

#### *FUSION IN THE IMAGE DOMAIN*

They directly produce a tone mapped- like HDR image. However, methods that fuse the images in the radiance domain produce a true HDR radiance map in the combination step which contains the whole dynamic range of the captured scene. This radiance map can later be used for different processing or display applications.

This is the other methods combine multiple exposures directly without the knowledge of the camera response function these methods combine LDR images by preserving only the best parts of each exposure. The final HDR image is obtained as a weighted average of pixel values across exposures

$$I_{uv}^c = \sum_{k=1}^n W(z_{uv}^k) z_{uv}^k$$

Where  $I_{uv}^c$  is composite image The choice of the weighting function is crucial to get good and accurate results. Combine multiple exposures using contrast, saturation and well- exposedness as parameters for weighting functions. They also use a Laplacian pyramid blending framework to avoid artifacts in the composite image.

### IV. LITERATURE VIEW

Jeena Baby (2013) et al present that a survey of various image contrast enhancement techniques has been done. Color image enhancement plays an important role in digital image processing. Contrast enhancement is an optimization problem and is done for the images which are experiencing poor quality. Poor quality of images is due to various factors like environmental lighting conditions, defects in photographic devices, etc. Therefore image contrast enhancement is important in order to improve the human acceptance rate. Most of the papers are based on histogram equalization

technique and its extensions. Histogram equalization is a contrast enhancement technique based on the histogram of the image. Each technique has got its own advantages as well as disadvantages. Various contrast enhancement techniques have been proposed by different authors as an extension of the traditional histogram equalization. They are power constrained contrast enhancement, dynamic range compression, color model conversion, gamma correction and channel division methodologies. Several recent papers are being surveyed under each technique. The different contrast enhancement techniques were analyzed. Other than contrast enhancement power constraints are also considered. Power saving is an important factor in the multimedia devices. The major issue faced by most of the images is noise. Various techniques have been examined for the image noise reduction. Color model conversions are important when the processing of RGB images is tedious. Most of the techniques are the extensions of the traditional histogram equalization. [10]

Kesharee Singh (2014) et al present that an efficient technique for the contrast enhancement is implemented along with the reduction of noisy pixels in the HDR images. HDR images are special images that contain high intensity pixels on which various techniques such as contrast enhancement, brightness enhancement, filtering, segmentation is very difficult, but the technique implemented here not only improves the contrast of the image but also reduces the noise level of the pixels. The resulting analysis shows the performance of the proposed technique. The comparison is done on the basis of certain parameters such as PSNR, time computation, error rate and smoothness factor. In this technique implemented here is efficient in terms of smoothness and time. Various HDR images are tested on the existing technique using Local Tone mapping and the proposed technique using the hybrid combinatorial method of kernel padding and linear transformation and histogram equalization and the result analysis shows the performance of the proposed technique. The proposed technique is efficient in terms of error rate, PSNR, computational time and the smoothness factor. [11]

Dejee Singh (2013) et al presents that Image blur is the challenging to purpose of avoid in numerous circumstances and can often ruin a photograph. Image deblurring and re-establishment is the compulsory in digital image processing. Image deblurring is a procedure, which is used to make pictures sharp and valuable by using mathematical models. Image deblurring have wide applications from customer photography, e.g., eliminate motion blur due to camera shake, to radar imaging and tomography, e.g., eliminate the outcome of the imaging method response. There have been many techniques that were proposed in this regard and in this paper, we will scan dissimilar approaches and methods of deblurring. The examination is done on the basis of presentation, kinds of blur and Peak Signal to Noise Ratio (PSNR). [12]

Ronan Boitard (2013) et al present that HDR (High Dynamic Range) video acquisition and show is currently attainable TMOs (Tone Mapping Operators) change High Dynamic Range images to LDR (Low Dynamic Range) ones. However, these operatives don't take into an account the temporal association existing in a video series. He present in this article, two main problems that arise when dealing with video tone plotting: bickering and temporal brightness incoherency.

Flickering corresponds to fast modifications of either tone map curve or scene content. He then suggest a survey of the methods that resolve these problems. Outcomes display that while certain problems have been well studied and resolved, others still requirement additional effort. We \_rst described two main issues when tone mapping HDR video sequences: ickering arti- facts and brightness incoherency. We addressed two kinds of ickering artifacts. The \_rst one, due to the used TMO, has been well studied in the literature. Many techniques have been proposed to reduce this ickering. Some of them apply to only one TMO while others can adapt to any TMO. The second one cor- responds to changes in the scene content. Existing TMOs are not capable of coping with this kind of ickering. Finally, we presented a solution to preserve brightness coherency when applying a TMO. [13]

Ji Won Lee et al. Proposes a noise reduction method and an adaptive distinguish improvement for the local TM (Tone mapping). The offered local Tone mapping procedure compresses the luminance of HDR (high dynamic range) Image and decomposes the compressed luminance of a high dynamic range image into multi-scale sub bands using the discrete wavelet transform. In case of noise reduction, the stale images are filtered using a soft-thresholding and bilateral filter, then, the active ranges of the clean sub bands are improved by considering local contrast applying the changed luminance compression function. At the color tone-mapped image is reproduced applying an adaptive saturation control factor and generate the tone-mapped image using the projected local TM. Computer imitation by noisy high dynamic range images displays the efficiency of the offered local Tone mapping procedure, in terms of visual value as well as the local distinguishes. It can be used in numerous shows with noise reduction and contrast improvement. The images that can be tone-mapped with the proposed local TM algorithm give better image quality than those of the conventional TM algorithms. That is, the proposed local TM algorithm effectively reduces coarse-grain noise and enhances the local contrast. [14]

Yen-Ching Chang and Chun-Ming Chang have proposed a new framework for the contrast enhancement using histogram equalization. Here in this technique to support and boundary values are taken and the values of the image are set according to these values. The proposed technique successfully reduces the washout appearance and Reduces artifacts of the image. [15]

Chen Hee Ooi and Nor Ashidi Mat Isa proposed the new way of enhancing the contrast of the images using Quadrant dynamic histogram equalizations. The proposed QDHE is the most robust method to extract the details of the low contrast images. Observing from the simulation results obtained, the QDHE has produced the best performance for both qualitative and quantitative evaluations. [16]

Haiyan Zhao offers the thought regarding article combines with human visual feature to check digital watermarking technique to insert watermarks, extracts watermarking in line with the harm state of affairs of watermarking, and that combines with other visual redundancy feature to attain an image scrambling algorithmic program that's simple to recover and a recovery time for broken scrambling image. Abstract-HVS theory plays a necessary role within the application of

digital image watermarking method. Once insert watermarking, the visual masking feature of HVS can be totally wanting to style digital watermarking algorithmic program with smart perceived performance. Once extracting watermarking from the broken image, human's visual feature can be combined to recover the broken image thus to acquire higher result. This rule might be applied in a digital image Watermarking rule to strengthen the hardness of watermarking rule. [17]

Wen-Chieh Lin and Zhi-Cheng Yan proposed a local tone mapping method that compliments both attention And adaptation effects. We accept the High Dynamic Range (HDR) saliency chart to calculate an attenuation chart, which predicts the attentive regions and non attentive regions in an HDR image. The attenuation chart is then used to locally regulate the contrast of the high dynamic range image according to attention and adaptation models found in psychophysics. These practical their tone mapping approaches to high dynamic range images and videos and compared with the results produced by three state-of-the-art tone mapping procedures. This experiment shows that their method creates outcomes with superior image quality in terms of preserving particulars and chromaticity of visual salience.[18]

## CONCLUSION

In this paper, we understand about the High-dynamic-range imaging (HDRI or HDR) is a set of methods used in the imaging and photography to reproduce a superior dynamic range of luminosity than regular digital imaging or photographic methods can do. And also we are studying about HDR image, generating of HDR image and also study about image fusion and methods of image fusioning.

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