Image Tone Mapping for an HDR Image by Adoptive Global tone-mapping algorithm

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Abstract

It is the age of fast and good quality Digital images, those are subject to blurring due to many hardware limitations, such as atmospheric disturbance, apparatus noise and poor focus quality. Visual saliency aims to predict the attentional steady intent look of observers viewing a scene, and therefore tone mapping of high dynamic range (HDR) images concept is highly useful for it. The work has focused on incorporation of saliency-aware weighting and edge-aware weighting into local tone-mapping algorithms for HDR images. The visual quality of the tone-mapped resultant image, especially the attention-salient areas, will be improved by the saliency-aware weighting. Experiments show that the proposed global scale tone mapping technique produces good results on a variety of high dynamic range images.

Keywords— *HDR Imaging, Exposure Determination, Tone mapping, local filtering*

I. INTRODUCTION

We experience in our daily life that the real world scenes often have a very wide range of luminance values. The Quality of image can be improved with the concept of lots of images of same object at the same position can be taken as the raw images. Human visual system is capable of perceiving the variation in the magnitude of the scenes over five orders of magnitude and can progressively adapt to scenes with dynamic ranges of over nine orders of magnitude. With the rapid improvement of digital imaging technology there is increasing interest in taking digital photographs that capture the full dynamic range of the scene of view. Although it is possible that future digital cameras would be able to capture high dynamic range (HDR) photos. Current technology often only enables part of the real world high dynamic scene visible in any one single shot. The fig (1) illustrates such a scenario, this is an indoor scene with the sunlight shining through the window and the camera was placed at dark end. In order to make features near the window visible, shorter exposure was used. However, this made the scene further away from the light source too dark. It increased the exposure interval to make the features in the visible dark end. To human observers, all features in the darkest as well as the brightest areas are equally clearly visible simultaneously. In fact, recent technologies have made it relatively easy to create numerical luminance maps that capture the full dynamic range of real world scene [1]. A HDR radiance map of a scene can be generated by using a sequence of low dynamic range (LDR) images of the same scene taken under different exposure intervals. The several works try to select the most appropriate LDR images to generate the HDR image where many LDR images with various exposures are already captured and stored; it implies that larger storage, as well as higher energy consumption is needed for such scenarios. In addition, it is not guaranteed whether the proper LDR images are already captured. The one simple method for HDR imaging is to use the LDR images with different exposure value (EV). Although it is feasible to obtain the HDR image using these exposure settings, HDR images quality is likely to be not promising due to the varying luminance condition, as well as the characteristics of each scene to be captured. This problem can be overcome in this paper by a technique to dynamically determining the exposure parameters. In this way, only the needed LDR images are captured. Moreover, not only an improved HDR image can be expected due to a supply of more suitable LDR images, but also a lower requirement of storage and power consumption can be achieved. Usually, there will be more details at the dark region for an image taken with a longer exposure time and there will be more details at the bright region for the image taken with a shorter exposure time. That is the reason why we can use several LDR images with different exposure settings to make the HDR image generation possible. Then, HDR image can be generated by combining these LDR images.

Fig 1: Digital photo of the same scene taken with different exposure intervals

Fig 2: Result of low dynamic range display mapped

from a HDR radiance map with a dynamic range But a conventional low dynamic range (LDR) image represents a scene at an exposure level with a limited contrast range. This results in the loss of details in bright or dark areas of the scene depending on the setting of exposure level. A high dynamic range (HDR) image overcomes the limitation of the LDR image, and it can preserve details in both the bright and dark areas of the scene well [1]. Therefore, an HDR image includes much more information than an LDR image. However, the display of an HDR image is an issue. Most current conventional display devices only have limited dynamic ranges and hence are unable to display HDR images. Due to the huge discrepancy between the ranges of HDR images and display devices, it is necessary to compress HDR images such that the appearance of both extremes of light and shadow regions can be reproduced on these ordinary LDR display devices simultaneously. Visual saliency was widely applied for the processing of the conventional LDR images, such as image/video compression, visual search, object recognition, etc. [2]–[5]. Since visual saliency aims to predict the attentional gaze of observers viewing a scene, it is highly demanded for the HDR images, especially for the display of the HDR images.

Simple Global Tone Mapping: A logarithm function is often used to approximate the non-linear encoding of the HVS. Thus, in the log-encoded image, equal steps in log-luminance correspond to equal visual sensations. This enables a perceptually uniform quantization where the perceived difference between two digital code values remains constant over the digital code value range. Such a logarithm function is used in the Retinex model of color vision. The organization of the paper is as follows. In section 2, we briefly review previous work. Section 3 presents experimental results and section 4 concludes the paper.

II. PREVIOUS WORK

A. Fast Tone-mapping

In few years a number of techniques have been developed for tone reproduction for high contrast images. There are two broad categories of technology [6]. Tone reproduction curve (TRC) based techniques manipulate the pixel distributions. previous pioneering work in this category include that of [7] which introduced a tone reproduction method that attempted to match display brightness with real world sensations. Recently, [8] presented a tone mapping method that modeled some aspects of human visual system. Recently, we have developed a learning-based TRC tone mapping method [10] and a fast TRC tone mapping method [11], for high dynamic range compression.. Often at multiple scales Tone reproduction operator (TRO) based techniques involve the spatial manipulation of local neighbouring pixel values. This type of technique is based on the image formation model:

$I(x, y) = L(x, y) R(x, y)$ which is elaborate in [6], [7] and [9]. Recent development has also attempted to incorporate traditional photographic technology to the digital domain for the reproduction of high dynamic range images [12]. An impressive latest development in high dynamic range compression is that of [13]. Human visual system is only sensitive to relative local contrast based on the observation that the authors developed a multiresolution hill domain technique.

B. Visual-Salience-based Tone mapping

While in Visual-Salience-based Tone mapping method for High dynamic range Images, a saliency-aware local tone-mapping algorithm is introduced for HDR images. Among the existing saliency models in [13]–[14], the saliency model in [14] is chosen to be extended from LDR domain to HDR domain due to its simplicity and robustness. The extended saliency model is adopted to set up a saliency-aware weighting for the processing of HDR images. The proposed saliency-aware weighting and a new edge-aware weighting are fused together to build up a content-aware weighting which is incorporated into the guided image filter in [14] to form a perceptually guided image filter. The new filter and the saliency-aware weighting are then applied to design a local mapping algorithm for HDR images. The three major components of the proposed local tone-mapping algorithm are the decomposition of the HDR luminance component into a base layer and a detail layer, the compression of the base layer, and the amplification of the detail layer. The proposed filter is applied for the decomposition of the luminance component of an HDR image. Since the proposed filter preserves sharp edges in the base layer better than the guided filter in [14], halo artifacts are significantly reduced in the tone-mapped image. After analysis of these two methods we concluded that if tone-mapped image has some halo artifacts then these types of artifacts can be minimized by using a saliency-aware local tone-mapping algorithm.

III. PROPOSED GLOBAL SCALE TONE-MAPPING

A. Simple Global Tone Mapping

where V is the input voltage, γ is the gamma value of the display and L is the luminance produced at the screen. This non-linearity has to be inverted in order to display luminance that corresponds to those of the captured scene. To do so, each color channel of an input image I is processed as follows:

$$I'_c = I_c^{\frac{1}{\gamma}} \tag{1}$$

Where c denotes one of the R; G; B color channel of the input image I, and I0 is the gamma corrected image. The value depends on the monitor; a common average value is 2:2. In addition to compensating for the display non-linearity, an advantage of the gamma encoding is that it approaches the functions described above that model the HVS non-linearity. Thus, a gamma-encoded image is also approximately perceptually uniform.

B. Adaptive Global Tone Mapping Technique

Our tone scale process is based on the subdivision of the image into its diffuse and specular components as well as on the range of display luminance that is allocated to the specular component and the diffuse component, respectively. Adaptive Global tone mapping algorithms apply the same function to all pixels of the image, i.e. one input value results in one and only one output value. They can be a power function, a logarithm, a sigmoid, or a function that is image-dependent. The Image I is represented as

$$I = \begin{cases} 0.95I & for\ I_x > 0.9I \\ I & for\ 0.1I < I_x < 0.9I \\ 1.25I & for\ I_x > 0.9I \end{cases} \tag{2}$$

After this formula the result is adapted and gets the outcome within the range that will not give the Aura in the image. And then the adaptive Global tone mapping methods are suitable for a scene whose dynamic range corresponds approximately to that of the display device, or is lower.

When the dynamic range of a scene exceeds by far that of the display (HDR scene), adaptive global tone mapping methods compress the tonal range too much, which results in a perceived loss of contrast and detail visibility.

IV. EXPERIMENTAL RESULTS

Tone mapping of HDR images is a very hot research topic in the fields of image processing and computation photography; there are dozens of tone-mapping algorithms. The fast tone-mapping technique has been tested on a variety of high dynamic range images. The luminance signal is calculated as:

$L = 0.299*R+0.587*G+0.114*B$. Log($L$) is computed to compile a histogram. The dynamic range was divided into 256 intervals thus compressing the original high dynamic range to 256values for display. We use following formula to compute the output LDR pixels

$$R_{out} = \left(\frac{R_{in}}{L_{in}}\right)^{\gamma} L_{out} , \qquad G_{out} = \left(\frac{G_{in}}{L_{in}}\right)^{\gamma} L_{out}$$

$$B_{out} = \left(\frac{B_{in}}{L_{in}}\right)^{\gamma} L_{out}$$

Where L_{in} and L_{out} are luminance values before and after compression, γ controls display color (setting it between0.4 and 0.6 worked well).

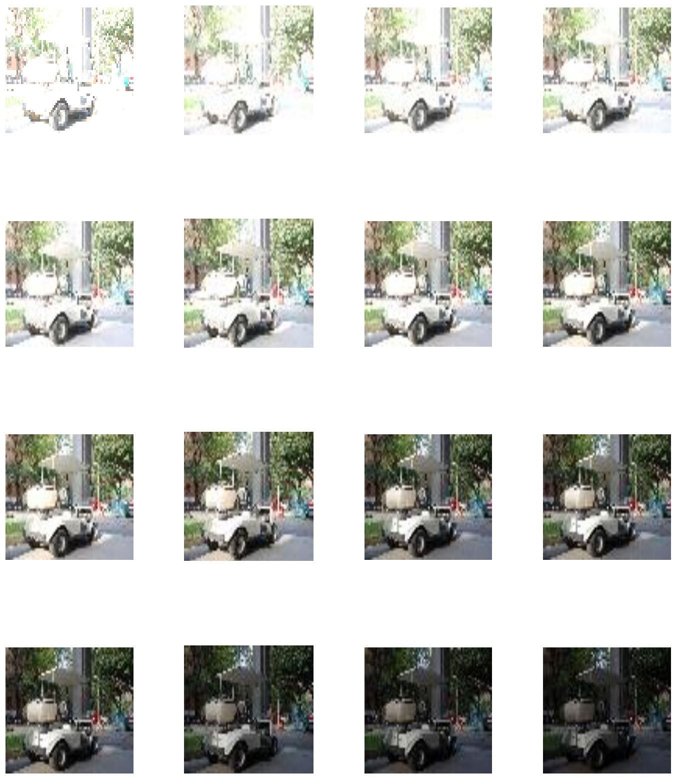
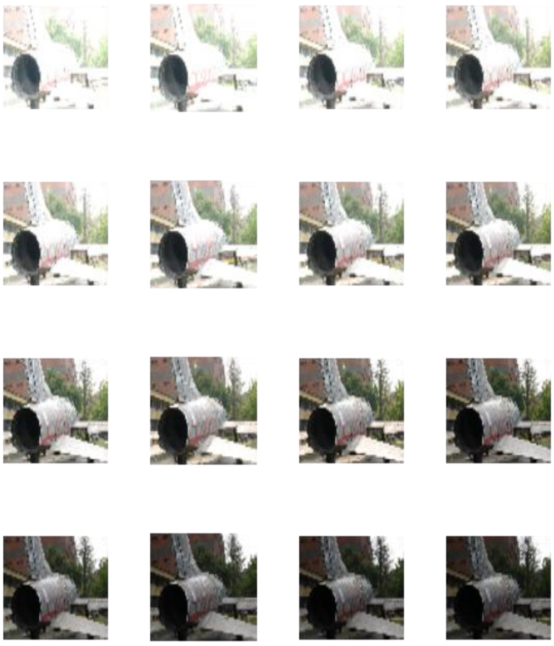
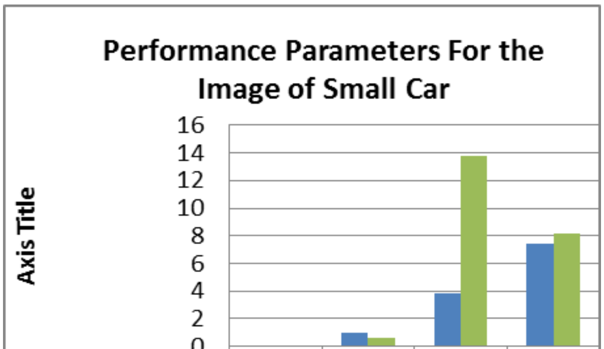


Fig.3 Mapped HDR images using fast tone mapping algorithm.





	Variance	Mean	SNR(dB)	UIQI
Previous	0.0882	1	3.823	7.4258
HDR Reconstruction using tone mapping (Proposed)	0.0281	0.5675	13.8238	8.149

Fig 4 Table and graph for the small car image.

The high dynamic range compression technique is very simple and efficient but it certainly loose some fine details of the scene.

Method	variance	mean	SNR(dB)	UIQI
Previous	0.2263	1.0000	3.8320,	7.4390

Proposed	0.0448	0.5040	8.2425	8.2104

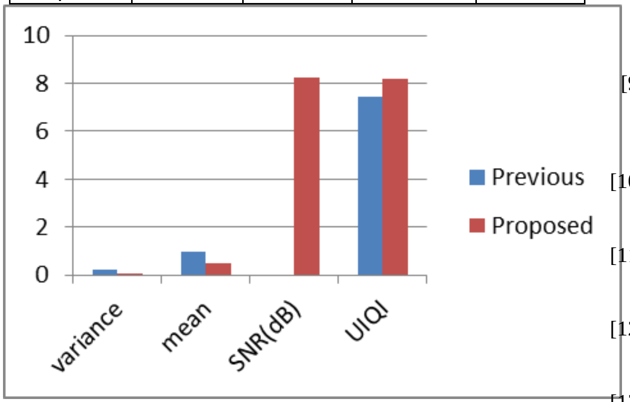


Fig 5 Table and graph for the plain image

Fig 3 top shows examples of mapped HDR images using fast tone mapping algorithm. A saliency-aware weighting and an edge-aware weighting into tone mapping of HDR images, the proposed local mapping algorithm provide best visual image quality and also free from halo effects when we compare with fast tone-mapping algorithm of HDR images. Figs 3 bottom show the examples of mapped HDR images using local tone mapping algorithm. Therefore from observation of two figures we see that the visual quality of tone mapped image is improved by using local tone mapping algorithm.

V. CONCLUSION

In this work we analysed the Novel saliency-aware weighting and edge-aware weighting and fast tone mapping methods for HDR images. The fast tone mapping algorithm is computationally efficient and very simple HDR imaging technology. The Novel saliency-aware weighting and edge-aware weighting applied to design a local tone-mapping algorithm for the display of HDR images on display devices with low dynamic ranges. Experimental results show that most of the halo artifacts have been avoided from appearing in the local tone-mapped image.

REFERENCES

[1] P. E. Debevec and J. Malik, “Rendering high dynamic range radiance maps from photographs,” in Proc. SIGGRAPH, Los Angeles, CA, USA, Aug. 1997, pp. 369–378.

[2] S. Grgic, M. Grgic, and B. Zovko-Cihlar, “Performance analysis of image compression using wavelets,” IEEE Trans. Ind. Electron., vol. 48, no. 3,pp. 682–695, Jun. 2001.

[3] J. Garcia et al., “Directional people counter based on head tracking,” IEEE Trans. Ind.Electron., vol. 60, no. 9, pp. 3991–4000, Sep. 2013.

[4] J. DiCarlo and B. Wandell, “Rendering high dynamic range images”, Proc. SPIE, vol.3965, pp. 392 – 401, 2001

[5] J. Tumblin and H. Rushmeier, “Tone reproduction for realistic images”, IEEE Computer Graphics and Applications, vol. 13, pp. 42– 48, 1993

[6] M. Ashikhmin, “A tone mapping algorithm for high contrast images”, Proc. Euro graphics Workshop on Rendering, P. Debevec and S. Gibson Eds., pp. 1 – 11, 2002

[7] G. W. Larson, H. Rushmeier and C. Piatko, “A visibility matching tone reproduction operator for high dynamic range scenes”, IEEE Trans on Visualization and Computer Graphics, vol. 3, pp. 291 – 306, 1997

[8] J. Duan, G. Qiu and G. D. Finlayson, "Learning to display high dynamic range images", CGIV'2004, IS&T's Second European Conference on Color in Graphics, Imaging and Vision, Aachen, Germany, April 5-8, 2004J.

[9] J. Duan and G. Qiu, "Fast tone mapping for high dynamic range images", ICPR2004,17th International Conference on Pattern Recognition, Cambridge, United Kingdom, 23 - 26 August 2004

[10] E. Reinhard, M. Stark, P. Shirley and J. Ferwerda, “Photographic tone reproduction for digital images”, Proc. ACM SIGGRAPH’2002

[11] R. Fattal, D. Lischinski and M. Werman, “Gradient domain high dynamic range compression”, Proc. ACM SIGGRAPH’2002

[12] K. He, J. Sun, and X. Tang, “Guided image filtering,” IEEE Trans. Pattern Anal. Mach. Learn., vol. 35, no. 6, pp. 1397–1409, Jun. 2013.

[13] L. Itti, C. Koch, and E. Niebur, “Amodel of saliency-based visual attention for rapid scene analysis,” IEEE Trans. Pattern Anal. Mach. Intell., vol. 20, no. 11, pp. 1254–1259, Nov. 1998.

[14] S. Lu and J. H. Lim, “Saliency modeling from image histograms,” in Proc. 12th Eur. Conf. Comput. Vis., Florence, Italy, Oct. 2012, pp. 321–332.