Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 9, September -2017

Asses the Performance of Tone Mapped Operator compressing HDR Images

[1]B. CHANDRA OBULA REDDY, [2]S. CHANDRA MOHAN REDDY

[1]*Digital Electronics and Communication System, JNTUACEP, Pulivendula, A.P, INDIA*
[2]*Associate professor of ECED, JNTUACEP, Pulivendula, A.P, INDIA*

Abstract— *with the developments in Image acquisition techniques there is an increasing interest towards High Dynamic Range (HDR) images where the number of intensity levels ranges between 2 to 10^4. Tone Mapping Operator (TMO) is used to convert the HDR image into Low Dynamic Range (LDR) images that can be visualized clearly there are different operators offered in the HDR tool box. The outputs of the operators are discussed in the paper with the objective analysis. Newly Logarithmic TMO and Exponential TMO are proposed and evaluation is done. Which are being compared with individual TMOs, give better results in quality metrics.*

Keywords—*component; Tone mapping operator, Logarithmic tone mapping operator, Exponential tone mapping operator*

I. INTRODUCTION

Tone mapping process is an important step for replica of “nice-looking” images. The obtained output values of display are mapping by this process for getting original image luminance. The contrast ratio of the images was measured by this technique at the comparison of an image pixel value with display value. The resultant value occurs smaller than pixel value then it expands the dynamic range by luminance ratio. The resultant value occurs larger than image pixel value then it compressed the dynamic range by luminance ratio. Whenever these displays are enters into the market that creates requirement for innovative tone mapping algorithms.

The natural scenes express at considerable range of luminance variation. The order of dynamic range could be on the order of 10^4 to 1 from brightest to darkest [1]. HDR images allowed capturing large amount of luminance levels between its brightest and darkest regions than standard or low dynamic range (LDR) images. A general problem that is frequently encountered in practice is concerned about the visualization of HDR images. Several display devices are available to design standard LDR pictures and not protect total information in HDR images. In development of HDR images are visualized by normal displays, many algorithms were proposed for tone mapping that convert HDR to LDR images [2]. It should be noted that due to the dynamic range decreases, tone mapping operators (TMOs) inevitably cause information loss. So the problem is, we have multiple TMOs on a hand, what type of TMO authentically preserve the information of the HDR image, and what type of TMO produces a quality of natural-looking LDR image.

The major objective of this paper is to initiate an objective quality assessment process for LDR images by considering HDR images as reference. Replica of this paper is integrated of two parameters through structural-fidelity measurement and naturalness assessment. The structural-fidelity measure is inspired by the achievement of the Structural Similarity (SSIM) Index shows correlated with perceived quality of image at testing with no. of independent HDR images. SSIM is modified to contain contrast across dynamic ranges.

This approach of naturalness assessment calculation is depends upon real image for brightness statistics. Though the model is simple, it shows too helpful and particularly identified to difficulty with processing, where brightness mapping is certain concern in the design of tone-mapping algorithms.

II. LITERATURE SURVEY

M.Cadwık and M.Wimmer designed Attributes of the image and Quality for assessment of Tone Mapping Operators [1]. In this, they have given a general review of image quality attributes of different tone mapping methods. Further-more, they have presented scheme of relationships between those attributes, leading to the definition of an overall image quality measure. Our effort is not just useful to get through the tone mapping tools or when the tone mapping operators are implemented, it sets the stage for well-founded comparisons between tone mapping operators. Good definitions of image quality providing through the different attributes, user-driven and automatic comparisons are made always possible.

Toshiyuki DOBASHI, Tatsuya MUROFUSHI and Masahiro IWAHASH developed Fixed-Point Tone Mapping Operator [2] for HDR Images in the RGBE Format their method decreases a computational cost. Experimental outcome shows the PSNR of LDR images in the method are comparable to those of the conventional methods. Their method can perform a TMO with only fixed-point arithmetic. This method computes the equation which is difficult to compute without floating-point arithmetic by branching and approximation.

In 2013 ZIJIAN ZHU proposed High Quality High Dynamic Range Imaging [3] where he had taken multiple input images which produce a new ghosting artifact due to moving object. A real time de ghosting method is first proposed by him using bi-directional comparison and IRF based moving object detection and patching. It is lightweight in terms of both time complexity and physical memory consumption, which makes it suitable for mobile devices.

Hojatollah Yeganeh and Zhou Wang [4] proposed Objective Quality Assessment of Tone-Mapped Images Here they have proposed an objective quality assessment algorithms for tone-mapped images by combining: 1) a multi-scale signal fidelity measure depend on a modified structural similarity index and 2) a naturalness measure depends on the intensity of natural images statistics. Validations using independent subject-rated image databases show good correlations between subjective ranking score and the proposed tone-mapped image quality index (TMQI).

III. PROPOSED METHOD

A. QUALITY ASSESSMENT METHOD

Total information contains in the HDR images cannot be stored by TMOs due to reduction of contrast ratio. A person observing LDR versions of these images were ignorant of it. For assessing the image quality utilized with TMO, structural-fidelity is essential. However, total quality assessment not provided by structural-fidelity separate. Structural-fidelity preservation and statistical naturalness are rarely testing factor in quality of image formed by fine TMO and cooperate between two in superior quality tone mapped image.

B. Structural Fidelity(S)

The SSIM [5] is the best technique for assessing structural-fidelity between images and practical SSIM approach is pursued. The SSIM algorithm is applied locally that compare luminance and structure between images. Let ‘a’ and ‘b’ are two local fields of image extracted from HDR and LDR tone mapped images. Whereσ_x, σ_y and σ_{xy} are the local standard-deviations and cross-correlation between two resultant fields in HDR and LDR images respectively. $C1$ and $C2$ are positive stability-constants. SSIM means comparison components of luminance and structure. In that, luminance comparison is varying and structure comparison component is accurately same.

$$S_{\text{local}}(x, y) = \frac{2\sigma'_x\sigma'_y + C_1\sigma_{xy} + C_2}{2\sigma'^2_x\sigma'^2_y + C_1\sigma_x\sigma_y + C_2}$$

The local structural-fidelity calculates S_{local} is applied to HDR image through sliding window that performs across image space. This results in map that reflects the variation of structural-fidelity across space. The sampling density of the image concludes the visibility of image, the space between the image and observer, resolution of display, and the perceptual capability of the viewer’s visual system. A single scale system cannot capture by variations. The local structural-fidelity map is generating at each scale and the map is pooled by mean to provide single score.

$$S_i = \frac{1}{Nl}\sum_{i=1}^{Nl} S_{local}(x_i, y_i)$$

Where $x_i$and $y_i$are i^{th} the patches of HDR and LDR images are compared respectively. The structural-fidelity scores:

$$S = \prod_{i=1}^{L} S_i^{\beta l}$$

Where L is whole number of scales and β_l is window allotted to i^{th} scale. The different parameters like structural-fidelity, naturalness and quality are provided in table. These parameters show that this method is important.

C. Statistical Naturalness (N)

Among the tested attributes, brightness and contrast contains additional correlation with apparent naturalness [6]. The two attributes are used to create statistical naturalness form. This selection consists over simplified thought of statistical image naturalness. It is likely to simplify different image processing applications that use process of naturalness. This model is ease and simple contains ability of capturing more important ingredients of naturalness that are associated to tone mapping assessment crisis and try to solve, where brightness mapping is not avoidable concern in total TMOs. The best complements of structural-fidelity explained in this section, where modeling and evaluation of brightness are omitted. Modern researches recommended that brightness and contrast are mostly independent quantities in terms of both natural image statistics and biological calculation .This results, joint PDF and their the product of statistical naturalness calculate as:

$$N = \frac{1}{K} P_m P_d$$

Where normalization factor (K) is: K=max {Pm Pd}. This restrains statistical naturalness measure to be enclosed between 0 and 1.

D. Quality Assessment Model (Q)

The structural-fidelity S and statistical naturalness N gives tone mapped quality images. S & N used individually or jointly as a vector valued measure.

$$Q = aS^a + (1 - a)N^\beta$$

Where $0 \leq a \leq 1$; adjusts relative importance of two components. α & β conclude their sensitivities. As both S & N are upper-bounded by 1, total quality measure is also upper-bounded by 1.

Logarithmic Tone Mapping:
Logarithmic TMO:

$$Ld = {}^{log2}/_{\log(1 + L_{max})}$$

$$Y = \Delta L(X, L, L_d)$$

Therefore, the logarithmic relation in tone mapping results as Stockham15 who recommended for image processing relation purposes. The luminance display L_d is ratio of world luminance L_w and maximum luminance in the imageL_{max} for every pixel. The mapping ensures that whatever the contrast ratio of scene is maximum value and remapped to white and other luminance values are easily increased. Though, the equation leads to nice images and found that compression of luminance is exceeds and loss of high contrast content.

EXPONENTIAL TMO:

Tone-mapping is inspired by the properties of Human Visual System (HVS) that simultaneously register dynamic range or contrast ratio in a scene. Computational efficiency tone-mapping naturally treats the luminance, and maintains colors from real image

$$L_d = 1 - e^{\frac{L}{L_{wa}}}$$

$$Y = \Delta L(X, L, L_d)$$

Here, L_{wa} m logarithmic mean value, L is the image luminance respectively. L_d is derived from ratio of Exponential of image luminance to logarithmic mean value. Exponential TMO is compress the maximum dynamic range image converges to standard image. It is calculated maximum mean value of pixel is remapped to standard scene.

IV. EXPERIMENTAL RESULTS

Output image glances

Image 1.Bottles Small image

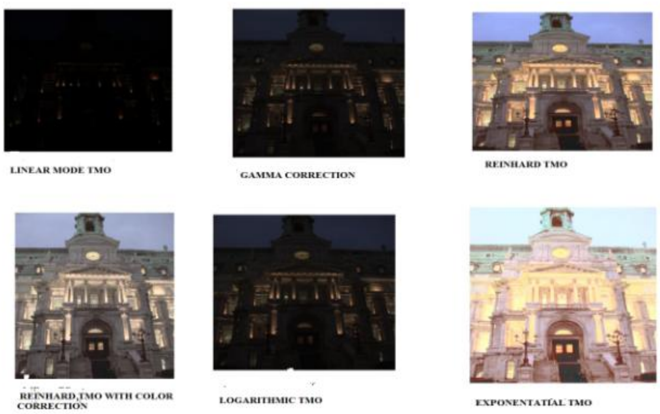


Image 3. Warwick

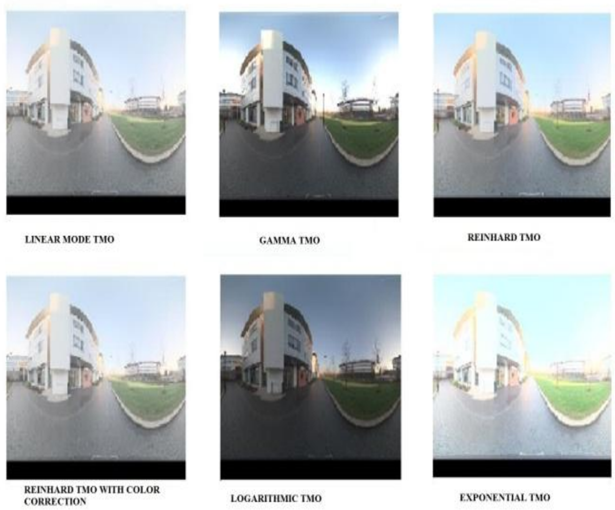


Image 3.CS_Warwick

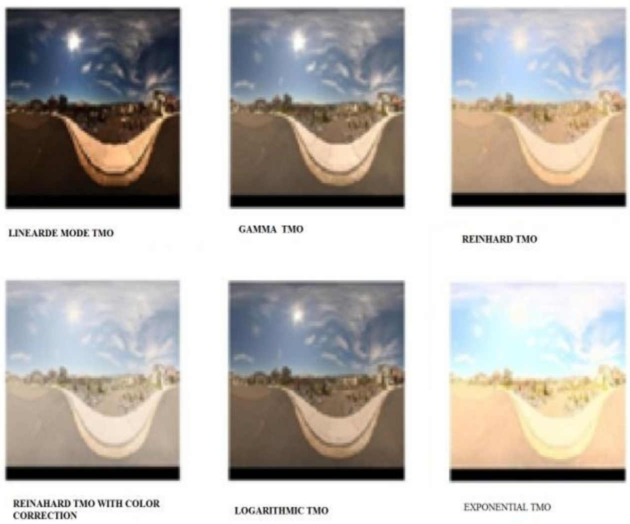


Image 4.Wc_sand art

In this paper various tone mapping operators are examined. As first step of the experiment existing operators are taken into consideration. Namely 1) Linear Mode Tone mapped operator, 2) Gamma Correction Tone mapped operator, 3) Reinhard Tone mapped operator, 4) Reinhard Tone mapped operator with color correction. The Study of quality metrics of the image like structural fidelity and structural naturalness examined and listed in the table. This study on the tone mapped operators leads us to create artifacts, loss of contrast resulting in a loss of detail visibility. Proposed TMOs that adopts the characteristics of the existing TMOs are developed which will produce a better image quality than the previous TMOs.

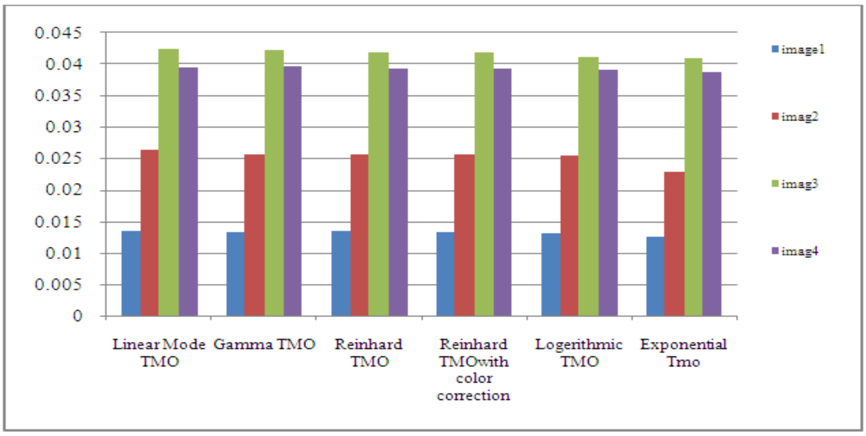
Table1: Structural Fidelity values

TMO	Image1	Image2	Image3	Image4
Linear Mode TMO	0.0136	0.0264	0.0424	0.0157
Gamma Correction	0.0133	0.0257	0.0422	0.0156
Reinhard TMO	0.0136	0.0258	0.419	0.0143
Reinhard TMO with color correction	0.0133	0.0258	0.0419	0.0142
Logarithmic TMO	0.0131	0.0257	0.042	0.0128
Exponential TMO	0.0126	0.023	0.0419	0.0135

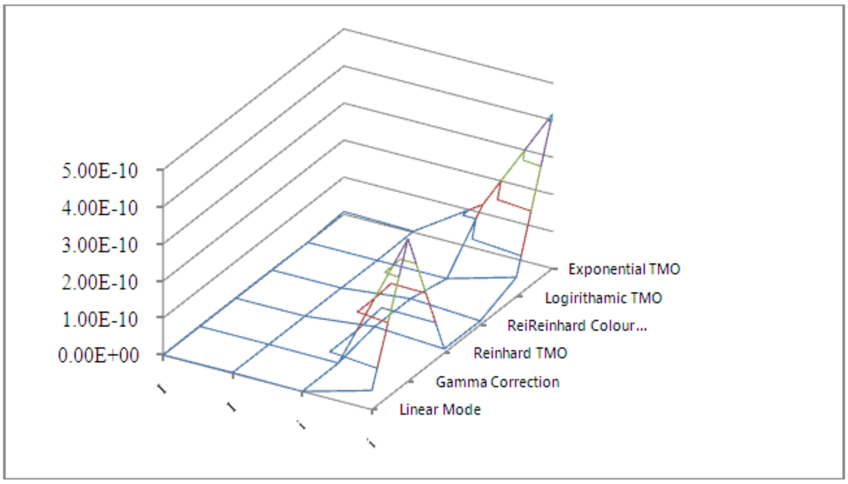
Table2: Structural naturalness

TMO	Image1	Image2	Image3	Image4
Linear Mode TMO	9.99E-13	1.92E-12	3.01E-13	5.1311e-11
Gamma Correction	1.96E-12	1.79E-12	8.94E-13	3.8438e-11
Reinhard TMO	1.79E-12	1.88E-12	7.37E-13	1.1281e-11
Reinhard TMO with color correction	1.77E-12	1.88E-12	7.37E-13	1.0583e-11
Logarithmic TMO	8.11E-14	1.38E-12	4.05E-14	5.2154e-11
Exponential TMO	7.11E-12	2.75E-12	1.42E-11	4.1696e-11

The Logarithmic Tone Mapping Operator and The Exponential Tone mapped operator are developed and executed to get an output image. The result of these operators displayed in figures



Graph.1 Structural Fidelity value

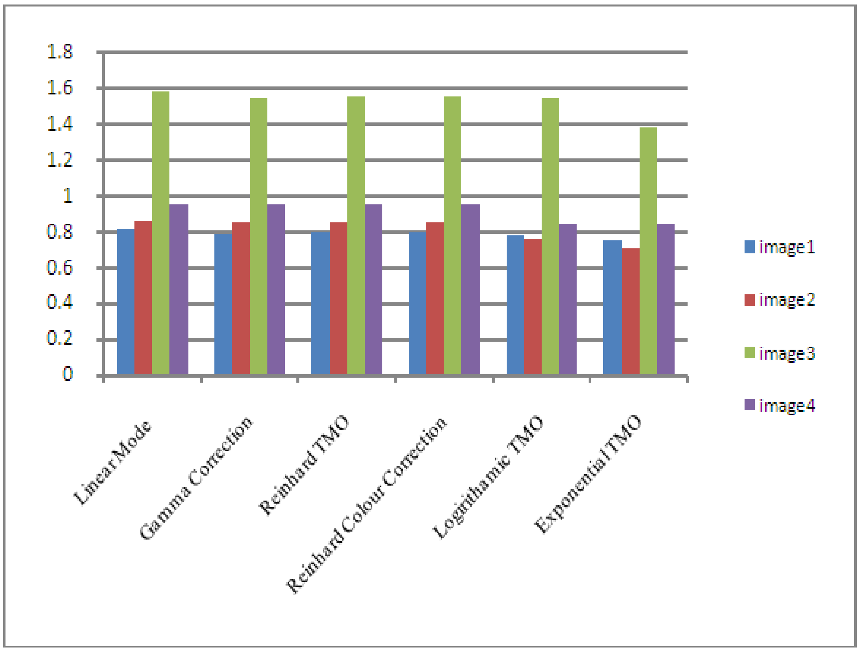


Graph.2 Statistical Naturalness

From the graph it is clear that result of structural fidelity and structural naturalness values of different tone mapping operator are silently differ in their reproduction. The graph inferences that total operators create approximately identical quality of images with slight difference in depending upon the parameters and the exposure. The obtained results help us to select the operator based on the request. Three dataset chosen for experiment and the results are revealed. To improve quality of image, TMOs are proposed and the results are shown with reference to the grouping of that they chose. The Quality metrics calculate of logarithmic and exponential TMOs to see in the Table below:

Table3: Quality metric

TMO	Image1	Image2	Image3	Image4
Linear Mode TMO	0.8188	0.8625	1.5816	0.9583
Gamma TMO	0.7953	0.8571	1.5444	0.9583
Reinhard TMO	0.8010	0.8568	1.5508	0.9559
Reinhard with color correction	0.8005	0.8529	1.5508	0.9559
Logarithmic TMO	0.7850	0.7659	1.5415	0.8445
Exponential TMo	0.7544	0.7110	1.3797	0.8438



Graph.3 Quality metric

V. CONCLUSION

By using the above mentioned four methods like linear mode ($\gamma = 1$), gamma correction ($\gamma = 2.2$), Reinhard TMO and Reinhard TMO with color correction we had generated 2 different TMOs namely logarithmic TMO and exponential TMO and asses their quality by comparing their performance with the existing TMO's. Our exponential TMO gives best compromise among contrast, quality and complexity. It provides better results in quality metric than the successive TMOs based on structural fidelity and naturalness measure.

The performance of Logarithmic TMO is good in the point of quality and the performance is good in the view of complexity. But the performance of the proposed Exponential TMO is very good in the point of both quality as well as complexity comparing to all other existing TMO's.

REFERENCES

[1] E. Reinhard, M. Stark, P. Shirley, and J. Ferwerda, "Photographic tone reproduction for digital images," in Proc. 29th Annu. Conf. Comput.Graph. Interact. Tech., vol. 21. 2002, pp. 267–276.

[2] F. Drago, K. Myszkowski, T. Annen, and N. Chiba, "Adaptive logarithmic mapping for displaying high contrast scenes," Comput.Graph. Forum, vol. 22, no. 3, pp. 419–426, 2003.

[3] E. Reinhard, G. Ward, S. Pattanaik, P. Debevec, W. Heidrich, and K. Myszkowski, High Dynamic Range Imaging: Acquisition, Display, and Image-Based Lighting. San Mateo, CA: Morgan Kaufmann, 2010

[4] A novel approach for contrast enhancement based on histogram equalization H Yeganeh, A Ziaei, A Rezaie - … and Communication Engineering, 2008. ICCCE 2008. …, 2008 Cited by 94.

[5] IRAWAN P., FERWERDA J. A., MARSCHNER S. R.: Perceptually based tone mapping of high dynamic range image streams. In Proc. of Eurographics Symposium on Rendering (June2005), Eurographics Association.

[6] B. Gi, W. Le, M. Ziu, and M. Wang, "Local edge-preserving multiscale Decomposition for high dynamic range image tone mapping," *IEEE Trans. Image Process.*, vol. 22, no. 1, pp. 70–79, Jan. 2013.

[7] H. Yeganeh and Z. Wang, "High dynamic range image tone mapping by maximizing a structural fidelity measure," in *Proc. IEEE Int. Conf. Acoust., Speech Signal Process,* May 2013, pp. 1879–1883.

[8] K. Ma, H. Yeganeh, K. Zang, and Z. Wang, "High dynamic range image Tone mapping process by optimizing tone mapped image quality index," in *Proc.IEEE Int. Conf. Multimedia Expor*, July. 2014, p. 1–6.

[9] M. ˇ Cadek and P. Slavek, "The naturalness of reproduced dynamic range image," in *Proc. 9th Int. Conf. Inf. Vis.*, 2005, p. 920–935.

