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Salient tone mapping operators for quality assessment of HDR images

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Abstract:

With the improvements in Image acquisition systems there is an increasing concentration in the direction of High Dynamic Range (HDR) images where the amount of intensity levels varies among 2 to 10,000. With these numerous intensity levels the exact representation of luminance variations is entirely possible. But, because the normal display devices are shaped to exhibit Low Dynamic Range (LDR) images, there is necessary to translate HDR images to LDR images without down significant image structures in HDR images. In this paper four TMOs like Reinhard, Gamma and color correction TMOs are evaluated .In this paper two novel TMOs are projected.

Keywords — **HDR, LDR, Tone mapping, Gamma correction.**

I. INTRODUCTION

Tone mapping be an important step for the reproduction of "good-looking" images. It provides the mapping connecting the luminance of the innovative view to the production device's display rate. While the dynamic range of the capture view is lesser or bigger than that of the display device, tone mapping expand or compress the luminance ratio.

A scene is assumed to be low dynamic range (LDR) while its dynamic range is lesser than that of the output standard. In this case, the dynamic range of the input image has to be expanded to fit the output medium dynamic range. A scene whose dynamic range matches approximately to that of the output medium is called standard dynamic range (SDR). A high dynamic range (HDR) image is the representation of an HDR scene whose dynamic range exceeds by far that of the output medium.

We tackle the trouble of tone mapping high dynamic range (HDR) imges to normal displays (CRT,LCD) and to HDR displays. With normal displays, the dynamic range of the capture HDR view must be compressed considerably which can persuade a loss of contrast ensuing in a loss of detail visibility. Local tone mapping operators can be used besides to the global compression to increase the local contrast and thence improve detail visibility, but this tend to create artifacts.

II. EXISTING METHOD

In 2006, M.Cadwik and M.Wimmer developed Image attributes and superiority intended for estimation of quality mapping operators. In this, they have presented an overview of image quality attributes of different tone mapping methods. Furthermore, they have proposed a system of relationships between these attributes, resulting to the characterization of an overall image quality measure.

In 2010, Toshiyuki DOBASHI, Tatsuya MUROFUSHI and Hitoshi KIYA built-up a Fixed point quality map function designed for hdr descriptions in the RGBE arrangement.Their future scheme reduce a computational rate. Tentative consequences show the PSNR of LDR imagery in the future scheme be equivalent to those of the predictable method.

Here two important existing tone mapping operators like Reinhardt mo, Reinhardt mo with color correction, Gamma correction tmo are presented.

A. *REINHARD TMO*

The tone replication trouble was first characterized by photographers. Many regular observations were extended over the 150 years of photographic practice [1]. At the similar time there were a crowd of quantitative measurements of media response distinctiveness by developers [2]. Ansel Adams effort to bridge this gap with method he called the zone system [3] which was initial developed in the 1940s and afterward accepted by Minor White [4]. It is a structure of "practical sensitometry", where the photographer utilizes measured information in the field to progress the occurances of producing a superior final print. The zone system is still broadly used more than fifty years after its foundation [5] [6] [7].

Zone: A zone is described as a Roman digit related with a rough luminance collection in a scene as well as a rough reflectance of a print. There are eleven print regions, varies from unpolluted black (zone 0) to unpolluted white (zone x), each twice in intensity, and a probably great huge amount of scene zones (Figure 1).

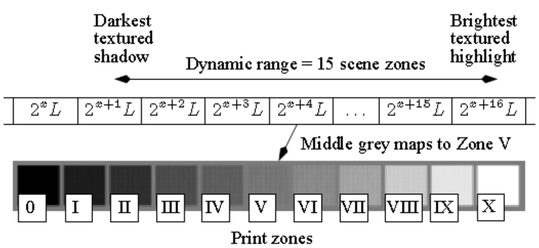

Figure 1: The mapping from view zones to publish zones. Scene zones at either intense will record to unpolluted black (zone 0) or white (zone X) if the dynamic range of the view is eleven zones or additional.

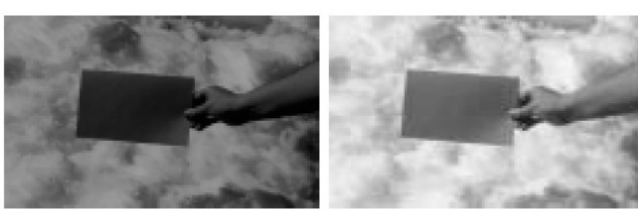

Figure 2: A standard-key map for a high-key view (for example containing snow) effects in an unsatisfactory image (left). A high-key map cracks the difficulty (right).

Figure 3: A photographer employs the Zone method to predict probable print troubles.

Middle-grey: This is subjective center brightness section of the view, which is naturally mapped to print zone.

Dynamic range: In computer graphics the dynamic range of a view is stated as the relative amount of the highest view luminance to the lowest view luminance. Since zones tell logarithmically to view luminances, dynamic range can be stated as the display between highest and lowest discernible view zones (Fgure 1).

Key: The key of a view specifies whether it is individually light, normal, or dark.A white painted room would be high-key, and a dim secure would be low-key.

Dodging-and-burning: This is a printing scheme where a little light is withdrawn from a portion of the print through development (dodging), or extra light is added to that section (burning). This resolve lighten or darken that section in the final print comparative to what it would be if the similar improvement were used for all segments of the print. In conventional photography this system is functional using a small wand or a part of paper with a hole cut out. The photographer former takes a luminance analysis of a surface he recognized as a center-grey (Figure 3 top). In a classic circumstances this is mapped to zone 5, which matches to the 18% replicate of the print.For high-key views the central-grey will be one of the dim areas, whereas in low-key views this will be one of the glow areas. This alternative is an imaginative one, although an 18% grey-card is frequently utilized to build this assortment procedure further mechanical (Figure 2). After that the photographer acquires luminance interpretations of both light and dark areas to choose the dynamic range of the view (Figure 3 bottom).

If the dynamic choie of the view not beat nine zones, suitable choice of middle grey can guarantee that all quality feature is asserted in the ending print. For sections where loss of detail is intolerable, the photographer can alternative to dodging-and-burning which will locally alter the enlargement process. The above system specifies that the photographic method is complex to computerize.

B.REINHARD TMO WITH COLOR CORRECTION

Although various tone mapping algorithms suggest complicated ways for mapping a true-world luminance choice to the luminance choice of the output standard, they frequently originate modification in color appearance. The main general tone manipulation is luminance compression, which frequently originates darker tones to show brighter and alters contrast associations. Figure 4B illustrates an HDR image following compressing luminance contrast by a aspect of 0.3 though maintaining pixel chrominance values (in words of the CIE xy chromatic coordinates). If, instead of compressing luminance, every three color segments (red, green and blue) are reduced, the consequential image is below-saturated, as illustrated in Figure 4C. To treat with this crisis, tone mapping algorithms frequently utilize an ad-hoc color desaturation scheme, which develops the outcomes but no assurance that the color appearance is conserved and involves manual parameter correction for every tome-mapped image (Figure 4D).

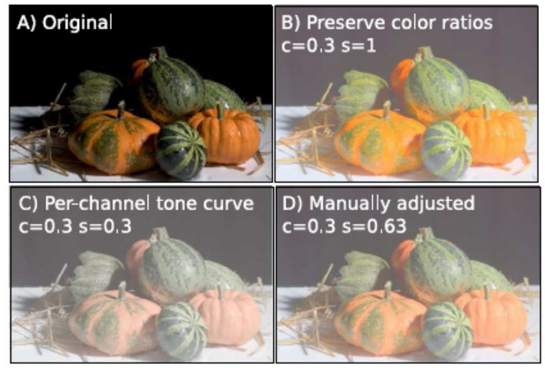

Figure 4: An inventive image A) differentiate with three images next contrast compression. Two usual color correction techniques B) and C) are differentiate with manual color correctionD). present color correction methods cannot correct colors for huge contrast compression.

The usual move to color handling in tone mapping, established by Schlick [8], is preserving color fractions:

$$C_{out} = \frac{C_{in}}{L_{in}} L_{out} \quad (1)$$

Where C indicates one of the color segments (red, green, or blue), Lis pixel luminance plus in/out subscripts denote pixels before and after tone mapping. Afterward documents on tone mapping, utilizes muscular contrast compression, viewed that the consequential images are more-saturated, as shown in Figure 4B, and advised an ad-hoc principle [9]:

$$C_{out} = \left(\frac{C_{in}}{L_{in}} \right)^{,2} L_{out} \quad (2)$$

Where s manages color saturation. The problem of the above equation is that it changes the consequential luminance for s6=1 and colors other from gray. This equation can change the luminance by as great as aspect of 3 for greatly color saturated pixels, which is an unwanted side effect. Therefore, we set up and examine in this paper a future rule, which provides luminance and occupies only linear interpolation among chromatic and matching achromatic colors:

$$C_{out} = \left(\left(\frac{C_{in}}{L_{in}} - 1 \right) s + 1 \right) L_{out} \quad (3)$$

C.GAMMA CORRECTION

Gamma correction is an integral printer aspect that permits users to vary the lightness/darkness stage of their prints. The quality of improvement is precised by a solo value varies from 0.0 to 10.0. Gamma correction might be precised on both a printer evasion and user-specific source across the network and on a printer evasion source through the printer's front panel. Gamma correction permits users to improved counterpart the intensity of their print to what they perceive on their computer screen (CRT). For example an image that appears just well on the CRT may print away dim on the printer. This is since the printer "gamma" (the feature traversal from dark to light) is dictinguish from that of the monitor. To fix this problem, the user can choose a "gamma curve" to be useful to the image ahead of printing that will lighten or darken the general tone of the image without influencing the dynamic range. The shape of the gamma curve is established by a numeral varies from 0.0 to 10.0 known as the "gamma value". Figure 6 shows various gamma arcs representing the result that the gamma value has on the outline of the gamma arc.

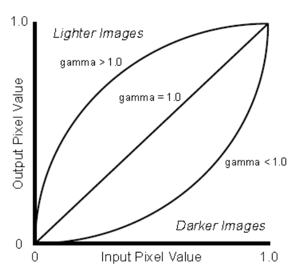

Figure 5: Gamma Curves

In Figure 6, the pixel values range from 0.0 indicating pure black, to 1.0 which indicates untained white. As the diagram shows, gamma ranges of down 1.0 darken an image. Gamma ranges extreme than 1.0 brightness an image and a gamma equal to 1.0 generates no consequence on an image.

The real gamma function employed within the printer is provide as follows:

$$newval(x) = x^{\left(\frac{1}{gammaval}\right)} \quad (4)$$

Where x is the unique pixel rate and gammaval is the gamma rate varies from 0.0 to 10.0. This curve is vital in keeping the pure black divisions of the image black and the white divisions white, though regulating the values in-relating in a smooth way. Thus, the entire tone of an image can be lightened or darkened based on the gamma value utilized, though maintaining the dynamic range of the image.

III. PROPOSED METHOD

We propose a fast, high quality tone mapping techniques to exhibit elevated contrast images on tools with bounded dynamic range of luminance rates. These techniques are Logarithmic tmo and Exponential tmo. Our Logarithmic and Exponential tmo techniques are capable of creating perceptually adjusted images with high dynamic substance and operates at interactive speed.

A.LOGARITHMIC TMO

We intended a perception-based tone mapping algorithm for interactive show of high contrast pictures. In our algorithm the picture luminance values are reduced using logarithmic utilities, which are calculated using different.

Algorithm for Logarithmic TMO

Input: HDR image – I

Output: LDR image – im.

Step 1: L←Luminance of I
Step 2: Lmax← maximum luminance value
Step 3: Ld← log(2)/log(1+LMax)
Step 4: im←ChangeLuminance (I, L, Ld)

B.EXPONENTIAL TMO

In terms of color replication, a few operators generated results constantly too bright (Retina representation TMO, Visual adjusted TMO, Time-adjusted TMO, Camera TMO), or too dark (Virtual exposures TMO, Color look TMO, Sequential coherence TMO). That, though, was not as disturbing as the extreme color dispersion in Cone model TMO and Local adaption TMO.

Algorithm for Exponential TMO

Input: HDR image – I

Output: LDR image – im.

Step 1: L←Luminance of I
Step 2: Lwa←logarithmic mean value
Step 3: Ld← 1 –$e^{L/Lwa}$
Step 4: im←ChangeLuminance (I, L, Ld)

ChangeLuminance Function:

Input: HDR image – I, Old Luminance – Lold, New Luminance – Lnew

Output: LDR image – im.

Step 1: Remove the old Luminance
Step 2: im← (I*Lnew)/Lold

IV. RESULTS AND CONCLUSIONS

The simulation outcomes of Reinhard TMO are shown in figures 6, 7 and 8 on dissimilar images.

Figure 6: Reinhard TMO on 'small bottles_HDR' image.

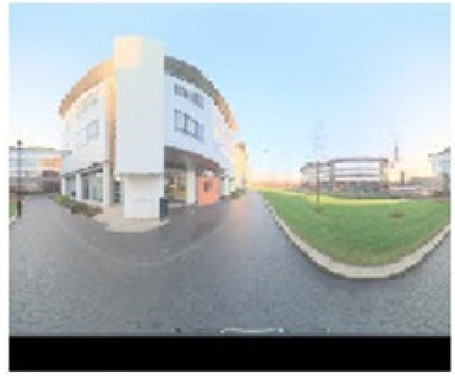

Figure 7: Reinhard TMO on 'cs-warwick_HDR' image

Figure 8: Reinhard TMO on 'oxford-church_HDR' image

The simulation outcomes of Reinhard color correction TMO are exposed in figures 9, 10 and 11 on dissimilar images.

Figure 9: Reinhard color correction process on small bottles_HDR image.

Figure 10: Reinhard color correction process on cs-warwick_HDR image.

Figure 11: Reinhard color correction process on oxford-church_HDR image.

The simulation outcomes of Gamma correction TMO are exposed in figures 12, 13 and 14 on dissimilar images.

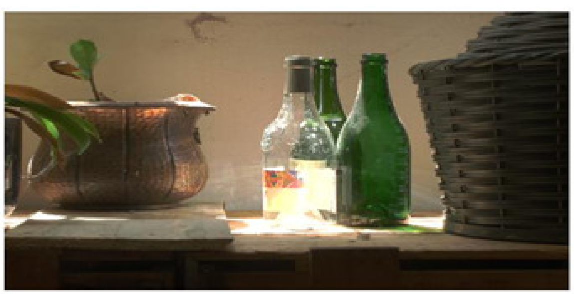

Figure 12: Gamma correction on small bottles_hdr image

Figure 13: Gamma correction on cs-warwick_hdr image

Figure 14: Gamma correction on oxford church_hdr image.

The simulation outcomes of Logarithmic TMO are exposed in the figures 15, 16 and 17 on dissimilar images.

Figure 15: Logarithmic tone mapped process on small bottles_HDR image.

Figure 16: Logarithmic tone mapped process on cs-warwick_HDR image

Figure 17: Logarithmic tone mapped process on oxford-church_HDR image

The simulation outcomes of exponential TMO are exposed in the figures 18, 19 and 20 on dissimilar images.

Figure 18: Exponential tone mapped process on small bottles_HDR image (Im-1).

Figure 19: Exponential tone mapped process on cs-warwick_HDR image (Im-2).

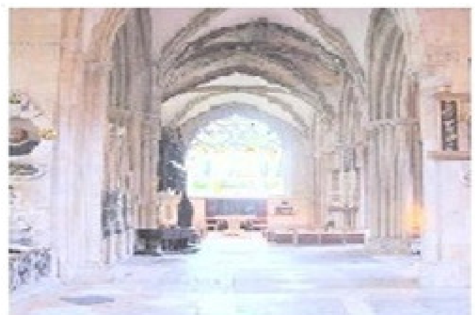

Figure 20: Exponential tone mapped process on oxford-church_HDR image (Im-3).

The assessment between dissimilar TMOs on dissimilar images is arranged based on Naturalness and structural similarity. These significances are specified in the tables 1 and 2. The simulation outcomes of above systems on dissimilar images are given in figures 21, 22 and 23.

Figure 21: TMOs on Im-4

Figure 22: TMOs on Im-5

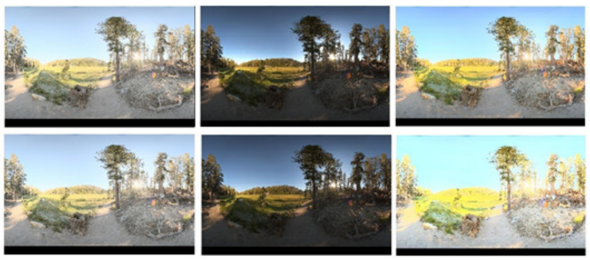

Figure 23: TMOs on Im-6

TABLE 1: NATURALNESS OF DISSIMILAR TMOs WITH DISSIMILAR HDR IMAGES

		Im1	Im2	Im3	im4	im5	im6
1	Linear Mode	1E-12	2E-12	3E-13	1.3E-12	1.5E-13	4E-12
2	Gamma Correction	2E-12	2E-12	8.9E-13	3.9E-13	6.7E-13	5E-12
3	Reinhard TMO	1.8E-12	2E-12	7.4E-13	1.5E-11	2.7E-12	7E-12
4	Reinhard Colour Correction	1.8E-12	2E-12	7.4E-13	1.5E-11	2.7E-12	7E-12
5	Logirithamic TMO	8.1E-14	1E-12	4E-14	5.5E-13	6.5E-14	1E-12
6	Exponential TMO	7.1E-12	3E-12	1.4E-11	3.2E-11	1E-11	9E-12

TABLE 2: STRUCTURAL SIMILARITY OF DISSIMILAR TMOs WITH DISSIMILAR HDR IMAGES

	TMO	Im1	Im2	Im3	Im4	Im5	Im6
1	Linear Mode	0.0136	0.0264	0.014	0.0424	0.038	0.04
2	Gamma Correction	0.0133	0.0257	0.013	0.0423	0.038	0.04
3	Reinhard TMO	0.0136	0.0258	0.013	0.0424	0.038	0.039
4	Reinhard Color Correction	0.0133	0.0258	0.013	0.0424	0.038	0.039
5	Logirithamic TMO	0.0131	0.0257	0.013	0.042	0.038	0.04
6	Exponential TMO	0.0126	0.023	0.014	0.0403	0.036	0.037

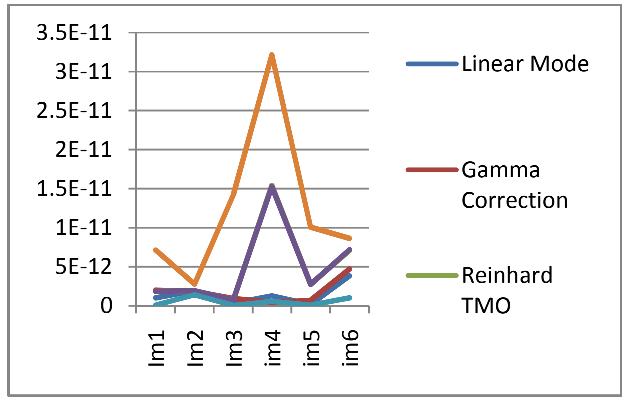

Figure 24: Naturalness of dissimilar TMOs with dissimilar HDR Images

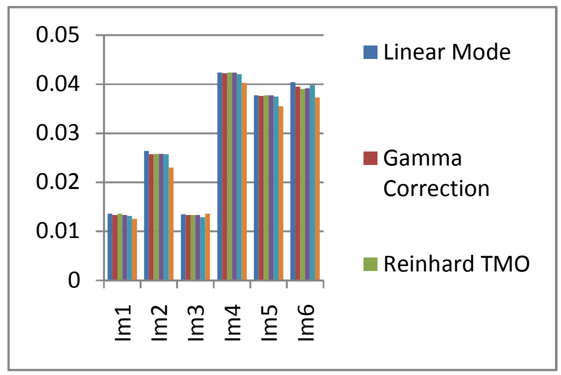

Figure 25: Structural Similarity of dissimilar TMOs with dissimilar HDR Images

CONCLUSIONS

In this paper an effort has been prepared to know and investigate dissimilar tone mapping operators. Although various tone mapping algorithms suggested complicated ways for mapping a real-world luminance range to the luminance range of the production standard, they frequently originate modifications in color appearance. The main general tone manipulation is luminance compression, which frequently originates darker tones to show brighter and alters contrast relationships. Along with TMOs, in this paper color correction methods are established. Two new TMOs are suggested which mapped the tone of HDR images as analogous with the existing TMOs.

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