High Dynamic Range Image Tone Mapping By Local Edge-Preserving Multiscale Decomposition

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Abstract

The demand for high dynamic range images is increasing to view and to efficiently analyse the things in an image. In a lower dynamic range display these images need a tone mapper which uses decomposition to fit the images to display. At this decomposition the mapping has to be relevant and the edges has to be preserved. A novel filter is presented in this paper which efficiently maps the HDR images into the lower dynamic range displays and also performs decomposition with edge preservation. The locally adaptive property makes it stand out among the other filters. The final fitered image has local means everywhere and it preserves the local important edges. Multiscale decomposition is proposed here with three detail layers and one base layer. The reproduced image of our filter gives a good visualization and enhances the local details though it is decomposed.

Keywords: Decomposition, Multiscale.

I. INTRODUCTION

In general, dynamic range is nothing but the ratio between the maximum light intensity to that of minimum in that scene. The natural scenery contains larger dynamic range when compared with the range of the available displays. This HDR image at times is obtained by fusion of multiple images of the same area or thing at different exposures of light. The so formed image always overruns the available range of the displays. In order to overcome this mismatch in the range, mapping becomes essential to flatten the intensity distribution of the image. This compression is based on the groundwork that human visual system is more sensitive to high frequency component in comparison with low frequency component.

So the multiscale decomposition comes into the process of mapping. It separates out the base layer and the detail layer at different levels. The most preferred Gaussian filtering when used in decomposition causes halo artifacts in the output images.

II. PREVIOUS WORK

The classic retinex theory represents the image formed by capturing light in camera as the product of the illumination (L) and the reflectance (R).

$$\log(I) = \log(L) + \log(R) \qquad (1)$$

The illumination variation in an image normally will be much lower than that of reflectance but it has the high dynamic range. This theory focuses on separation, compression of dynamic range and then decomposition of the image. The separation is normally ill-posed and the decomposition with various other filters produces the artifacts in an image. The decomposition problem was overcome a little by edge preserving filter. Zeev Farbman views an image as a combination of a base layer and a detail layer.

$$I = B + D \qquad (2)$$

It is ill-posed in preserving the edges but gives an energy function to improve the result. G. Guarnieri et al. proposed an approach similar to retinex theory with edge-preserving effect. Here the illumination is larger or equal to the lightness that is received.

$$\iint (\omega|\nabla L|^2 + (L-1)^2)\, dx\, dy \qquad (3)$$

Where,

ω- the space varying gradient, in the above equation gives the condition that as the gradient is increased the decomposition of base layer also gets increased.

III. PROPOSED WORK

In this paper we propose a newer filter to give a high quality of the compressed high dynamic range images. This method does not produce any artifacts in the image. To obtain an artifact less HDR image we use the concept that an image can be splitted into base layer and detail layer. Normally a base layer is considered to preserve the local means in the image and the detail layer is assumed to preserve the oscillations around zero. As the process of determining which gradient data belongs to base layer and which belongs to detail layer, we assume that all the nonzero gradient data belongs to the one other than the base layer. As said above we then assume that the base layer is the mean of a whole image that is only the zero gradient information is preserved in the base layer. But when single decomposition is used the prestated assumptions does not make a difference. So we go for multiscale decomposition which decomposes an image into a single base layer and a number of detail layers.

$$I = B_0 + D_1 + D_2 + \dots + D_n \qquad (4)$$

The base layer is plain without gradient and the addition of base layer and detail layer forms the base layer of next level which contains the essential edges and local means.

The basic block diagram of our method is given in figure 1.The input HDR radiance image has to be converted into a gray image. After this the image is changed to fit in the logarithm domain. To efficiently use the logarithm function, we randomly magnify the luminance times. It is calculated as follows,

$$L=\ln (L_{in} \; . \times 10^6 + 1) \qquad (5)$$

Where,
ln is the natural logarithm

Then the gray image is scaled to [0,1].this is done by the equation

$$L' = L / \max (L) \qquad (6)$$

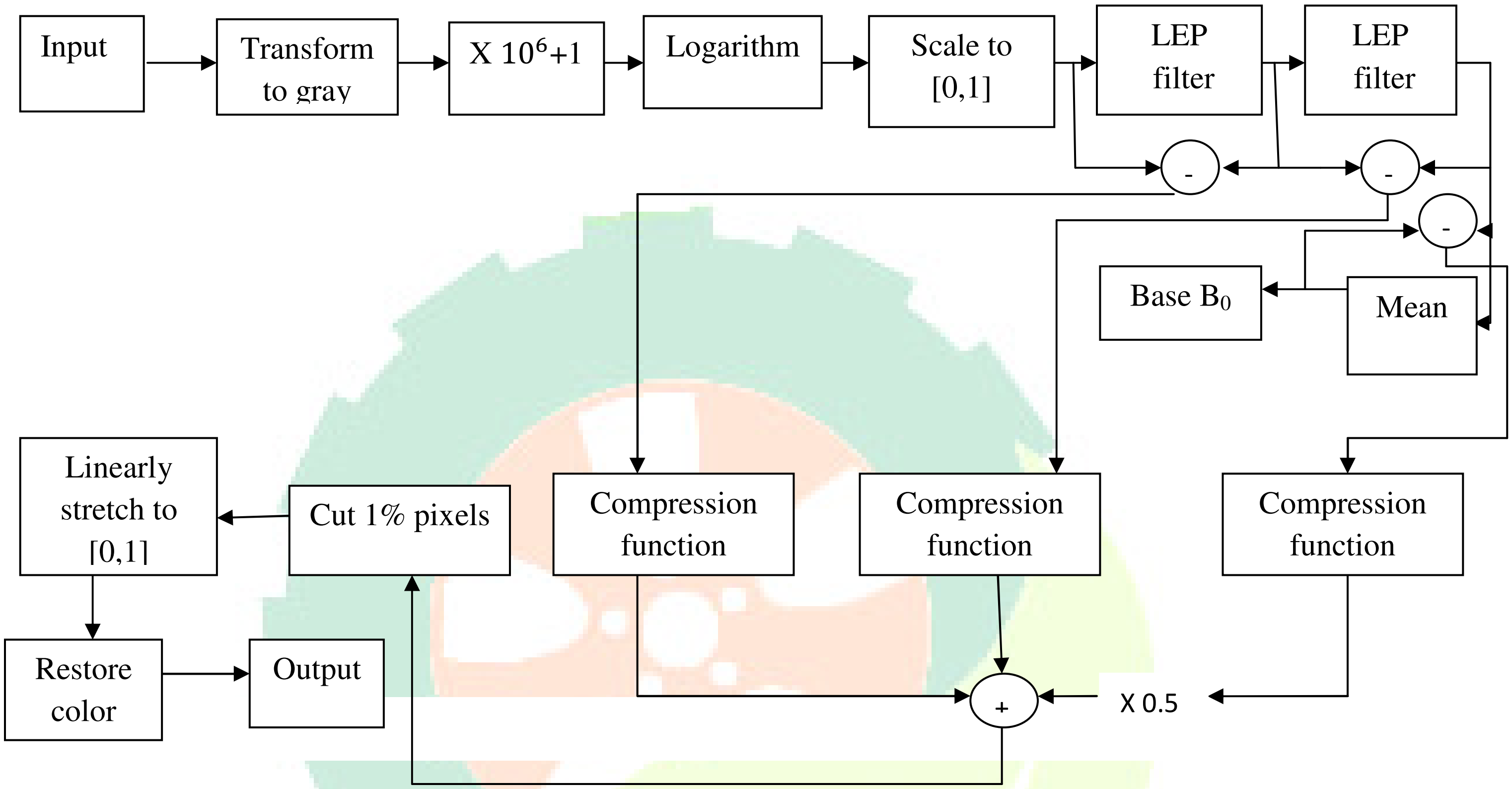

Figure 1 Block diagram of Proposed Algorithm

In the LEP filter blocks we give the value α'= 0.1 and β=1.The choice of window radius is 2 for the first and 20 for the second decomposition. The only point to be considered is that the first radius must be as small as possible to attain the fine scale decomposition. After the LEP filter the dynamic range compression is done. As detail layer value oscillates around zero, we need the compression of larger deviations and enhancement of lower ones. This is achieved by sigmoid function which is convex to overcome gradient reversal.

$$y = 2.\arctan(x .20) / \pi \qquad (7)$$

A special operation is being used after the compression stage. As the mean has been used after two decompositions, the last detail layer has higher dynamic range. So it is divide to half its range.

$$L_{out} = D'_1 \,.\, 0.5 + D'_2 + D'_3 \qquad (8)$$

Where D'_1 , D'_2 , D'_3 are compressed detail layers.

Finally 1% of the available pixels are cut in order to decrease noise and increase pixels' contrasts. Eventually the range is stretched to [0,1] and the color is restored to give the output image.

IV. RESULTS AND DISCUSSION

The assessment of our result is based on two measures. One evaluating measure is image sharpness. This is calculated as sum of all gradients:

$$S=\frac{1}{N}\sum|\nabla I| \quad (9)$$

Where N is the number of pixels in the image I.

Another measure is the quality which is the combination of structural fidelity which is full reference assessment and naturalness which is no reference assessment.

Here we have compared our result with WLS tone mapped and have found that ours preserves details everywhere.

TABLE I Performance Evaluation

Image	Sharpness	Naturalness	Structural fidelity	Quality
WLS	11.049	0.746	0.940	0.939
LEP	16.067	0.733	0.985	0.940

Figure 2 (a)proposed output, (b)wls output, (c) blf output

V. CONCLUSION

We have presented a local edge preserving filter which is based mainly on the assumption that the local means is preserved in the base layer. This filter presents only two parameters that has to be set. Comparison shows that our method supersedes the existing ones in its mutliscale decomposition. This algorithm not only compresses but also reproduces the HDR images.

VI. REFERENCES

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