IJETST- Vol.||02||Issue||05||Pages 2365-2371||May||ISSN 2348-9480 2015

Open access Journal International Journal of Emerging Trends in Science and Technology

A Novel Approach to Implement Local Edge Preserving Filter for High Dynamic Range Image Tone Mapping

Authors
Ashwin.C[1], Vijaya Kumar.T[2]
[1]M.Tech, ECE Department, S.J.B. Institute of Technology, Bangalore, India
[2]Assoc. Professor, ECE Department, S.J.B. Institute of Technology, Bangalore, India

Abstract
Edge detection is mainly used in image processing, and is used for feature selection and feature extraction. Edge preservation is important in filtering design to avoid the halo artifacts. Edge preserving decomposition of an image can be achieved using a Local Edge Preserving (LEP) filter. This technique is suitable for High Dynamic Range (HDR) images. Here, multi scale decomposition process is used, in which the image is divided into base layer and detail layer. The output of LEP provides better visual quality to the images. The problem of LEP filter is that it is not capable of eliminating the noise at the output completely and the smoothening performance of the LEP filter is poor compared with the previously established filters. Therefore a median filter is used as the preprocessor. The median filter has the ability to preserve the edges, and the capability to remove the noise present at the input. Thus, the LEP filter performance gets improved by using the median filter as the preprocessor.
Index Terms-- *High dynamic range image; local edge preserving filter; LEP-median architecture; multi scale decomposition; tone mapping; quality analysis.*

INTRODUCTION

Edge detection is one of the important steps involved in image processing. For detecting the edges an edge detector is applied. The result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects. Thus, application of an edge detection algorithm to an image may significantly preserve the important structural properties of an image. Thus subsequent task of interpreting the information contents in the original image may therefore be able to be simplified. When we are capturing images using digital cameras, the dynamic range [1] is the main factor which is given as the relation between higher and lower intensity components. Creation of a high dynamic range [HDR] image is made by the fusion of multi-exposure images [2]. The created HDR image in such a way may exceed the dynamic range of systems. Therefore, the compression process is needed for compressing the intensity distribution of this HDR image, which process is based on the characteristics of the human visual system (HVS). The HVS is characterized by the property that it is less sensitive to the low frequency components than the high frequency components. Thus the low frequency components are compressed while the high frequency components are retained.

BACKGROUND

In Retinex theory [3],[4] simulates the decomposition of an image into an illumination image and a reflectance image. The illumination image is the low frequency component, and the reflectance image represents to the high-frequency component. The compressed image may have to be converted back to the HDR image. For the decomposition process Gaussian filters were used. Later, for producing much improved outputs bilateral filtering is used instead of the Gaussian filter. However both filters suffer from noise and other side effects [5].

For avoiding these types of noise and side effects edge preserving becomes an important factor in filtering design. This type of techniques where, decomposes an image into base layer, which contains both low frequency band and salient edges and detail layers, which are further divided multiply [6], [7].

Edges to be preserved are selected on the basis of global and local importance. All these edges are important and they have to be preserved, thus giving a more pleasing visual quality of the image. For enabling better detail extraction, the local edge preserving (LEP) filter is used. The performance of LEP filter is better in structural fidelity, naturalness and overall quality than the WLS filter [6], bilateral filter and the other filtering methods. The main advantage of LEP filter from other filtering techniques was the capability of extracting more information as even the local edges are preserved. LEP filter also gave better structural fidelity, naturalness and overall quality than the other techniques. The problem of LEP filter is that it is not capable of eliminating the noise at the output completely since the reduced capability of working with noisy inputs and less smoothening capacity. So, a median filter is used as the preprocessor for LEP filter. The median filter has the capability of removing the noise present at the output and which also very well at preserving the output Thus, getting the improvement of the performance of the LEP filter. The output images visually and quantitatively compared with LEP filtered outputs using quantitative measures.

LOCAL EDGE PRESERVATION: ALGORITHM

Edge preservation using LEP filtering method is based on the classical retinex theory. An image decomposes into base and detail layers. Base layer contains zero gradients. Therefore after decomposition this layer can be discarded since which contains less information. Detail layer contains non zero gradients and therefore it is preserved.

Luminance = Base + Detail (1)

Detail= luminance - Base (2)

Where I represent the image's luminance and B represents the base layer. D stands for detail layer and which preserve for detail extraction. The block diagram of the local edge preservation using LEP filter is given in fig.1.

The Block diagram of LEP system contains:

1) HDR generation
2) Logarithm
3) LEP filter
4) Color reproduction

Performance of LEP is poor and will not work properly if any type of noise present at the input. At the output, it is not capable of eliminating the noise completely. We cannot guarantee that the input images will be always free from noisy distortions. To overcome this problem of LEP filter a median filter is used as the preprocessing step for LEP filter. The median filter has the capability to remove all the possible noises at the input images. Thus, the LEP filter can work properly and which giving exact outputs with good quality.

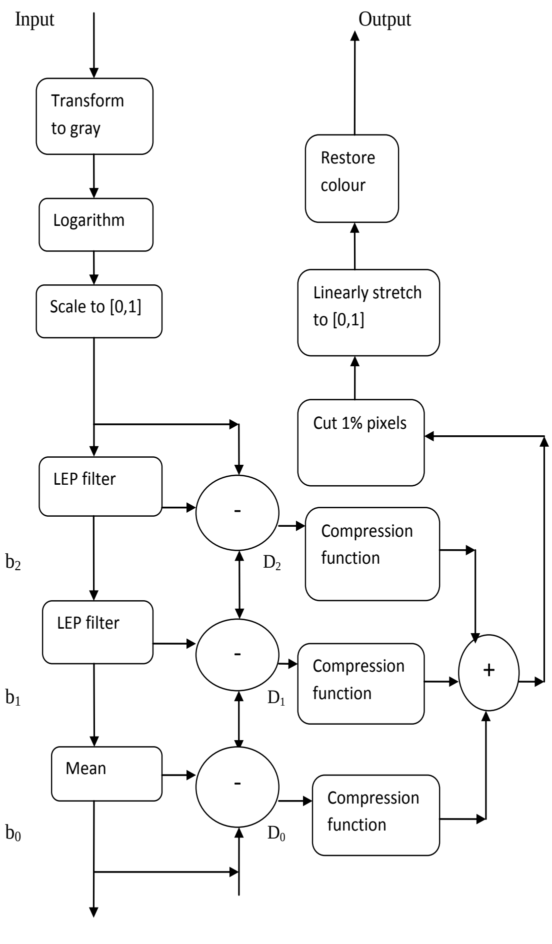

Figure 1. LEP system block diagram

MEDIAN FILTER AS PREPROCESSOR FOR LEP: SYSTEM ARCHITECTURE

The drawbacks of LEP filter are which is not capable of eliminating the noise at the output completely and the smoothening performance of LEP is very poor compared to the previously used filters. So, to overcome this problem a median filter is used as the preprocessor. The median filter is very good at preserving the output image, and at the same time, which is capable of removing the noise present at the input. The median filtered image given to the LEP filter Thus, the performance of the LEP filter gets improved.

The LEP-median system contains:

1) Preprocessing
2) HDR generation
3) Logarithm
4) LEP filter
5) Color reproduction

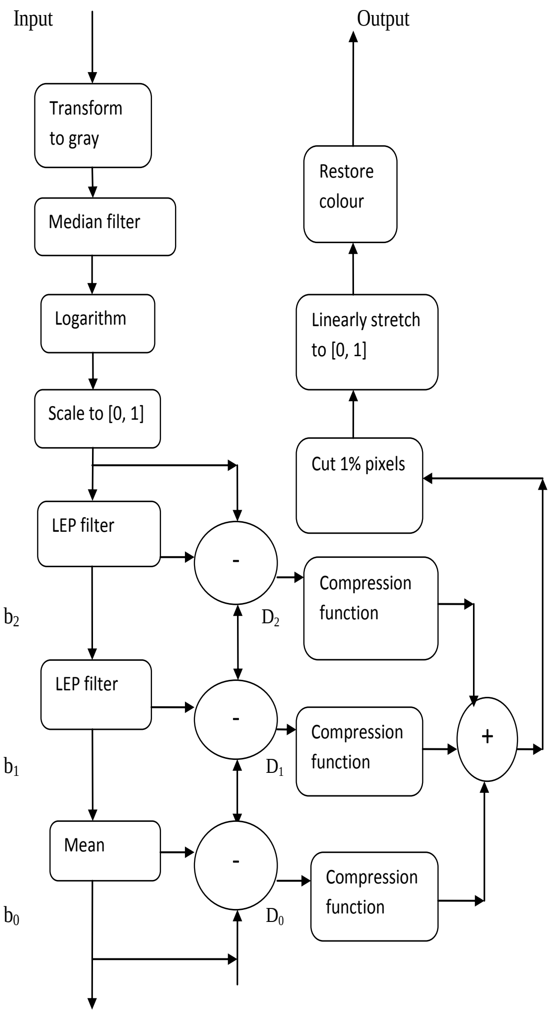

Figure 2. LEP-median system architecture

The description of the different modules in the system is given below:

A. Preprocessing

In the preprocessing step, if any noise or distortion in the input image is removed using a median filter. For swapping each pixel value in an image by the median of its nearest locality the median filtering is used. The processing steps of Median Filtering are given below:

- Arrange the pixel values
- Determine the Median
- Swap the pixel value by the Median.

The median filter is used rather than using any other filters for noise removal because of that to preserve even the local edges. Median filtering is a nonlinear filtering method, which is useful for eliminating the noises like impulsive and salt-and-pepper noise. Median filter is not only removing the noise in the image, but also it preserves the edges in an image. If it uses any other filters for noise removal, it may lead to edge distortion. For avoiding these problems, median filter itself is used as the preprocessor to LEP filter.

B. HDR Generation

By the fusion of multi exposure images, the High Dynamic Range image is created. The Lower exposure, middle exposure and higher exposure images are used for this HDR generation. High Dynamic Range [8] is the ratio of high intensity and low intensity components. Low Dynamic Range [LDR] image converted to HDR image.

C. Logarithm

For estimating the apparent radiance of an image the logarithm is used [9]. Here, randomly amplifies the luminance 10^6 times for getting good results. This can be estimated by,

$$L = \ln(L_{in} . 10^6 + 1) \quad (3)$$

Where ln( ) represents the natural logarithm. At last, the gray image is estimated by scaling L into the range [0, 1], L = L/ max (L) (4)

Here, max (L) represents the uppermost value of L.

D. LEP Filter

The two parameters of LEP filter are α' and β. For getting acceptable results the values of α' and β set as α'=0.1 and β=1. The performance of the filter depends on these values. These values have important role for LEP filtering. If α' or β is small, more gradients will be treated as prominent edges. When α' or β is large, the filtered output will be over smoothed. Therefore, by setting the nominal values for α' and β good performance results are obtained.

E. Color Reproduction

In the system block diagram, it is clear that, converting the colour image into gray scale image at first. The reason behind that, the MATLAB operators can be applied only to the gray scale images. So, finally restore the colour information by another conversion.

MODIFIED SYSTEM: ALGORITHM

A. Multi-Scale Decomposition

An LEP will give a base layer and a detail layer which can be viewed as the reference plane and contains local details respectively. All non-zero information is contained in the detail layer. Applying LEP will give base layer and detail layers and further, the detail layer is divided into multiple components given as:

I=B0+D1+D2+……… (5)

B. Tone mapping

For planning one set of colours to another in order to approximate the appearance to high dynamic range images in a medium that has a more limited dynamic range [10] the tone mapping procedure is used. To reproduce the full range of light intensities present in natural scenes limited dynamic range is insufficient [11]. Print-outs, CRT and/or LCD monitors, and projectors which are having limited dynamic range. To convert high dynamic range image into a form that is viewable in low dynamic range equipment the tone mapping is used [12].

C. Dynamic Range Compression

By the variation of the detail layers in a large extent which crosses the dynamic range. A compression function is used here to minimize this variation. This is an HDR compression which is used for minimizing the variations. Here uses the following function:

$$y = 2.\arctan(x.20)/\pi \qquad (6)$$

The profile is shown below in Fig.3. The variation of the function in the range $-\pi/2$ and $\pi/2$, and split it by $\pi/2$ to compress the range to [0, 1]. The input detail layers are converted to compressed detail layer output. The base layer is just disregarded. After compressing process, all the detail layers are added up to give the final output. This must be free of distortions [13], [14].

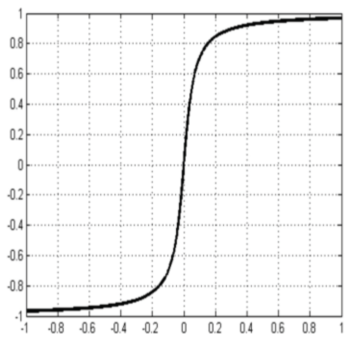

Figure 3. Compression function

RESULTS AND PERFORMANCE ANALYSIS

A number of noisy input images with different exposures are considered and are shown in the following figures. The lower exposure, middle exposure and higher exposure images are used to generate the HDR image.

Median filter, which is used as the preprocessor and with the use it the noise, can be removed. For constructing the HDR image the different exposure images are merged. Before that, using logarithmic approximations a logarithmic image is produced. Fig.5. shows the generated logarithmic image. To create the overall detail layer, the details are extracted from the different exposure images. The extracted detail layer is shown in Fig.6. The HDR image is constructed by merging the detail layers in the different exposure images. The generated HDR image is shown in Fig.7. Finally, the edge preserved output image is produced after LEP filtering which is shown in Fig.8.

Figure 4. (a) Lower exposure image (b) middle exposure image (c) higher exposure image

Figure 5. Logarithmic image

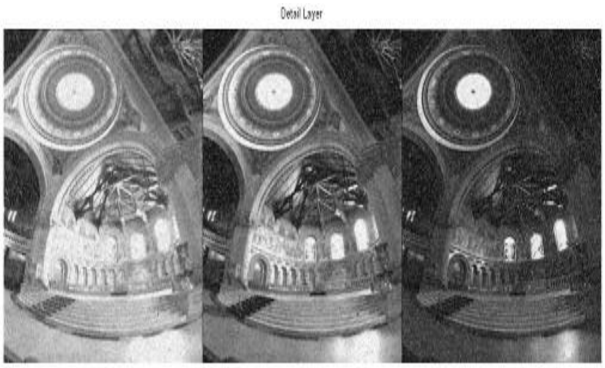

Figure 6. Extraction of the detail layers

Figure 7. Generated HDR image

Figure 8. LEP- median filtered output image

TABLE I.

Quality Analysis	LEP filtered image	Median-LEP filtered image
Structural Fidelity	0.0288619	0.0914666
Naturalness	0.016866	0.0203096
Overall quality	0.328902	0.399229

QUANTITATIVE MEASURE PERFORMANCE RESULTS OF TWO IMAGES

From the output images it is obtained that LEP-median filtered output image is better in structural fidelity, naturalness and overall quality than the existing LEP filter system. The quantitative measure is obtained by the objective quality assessment of the tone-mapped images. For analyzing the performances of the two filtering methods, the input images and output images of these methods are loaded separately into the objective quality assessment tool. Thus the measured values are obtained.

CONCLUSION

The main concept behind the LEP filter is multi scale decomposition. The advantage of LEP filter from other filtering techniques was the capability of extracting more information as even the local edges are preserved. LEP filtering gave better structural fidelity, naturalness and overall quality than the other techniques. But, the problem is the reduced capability of working with noisy inputs and poor smoothening capacity. These problems can be overcome by the use of a median filter as the preprocessor. It eliminates the noise and gives edge preservation. Experimental results show that median filtered LEP output gives more structural fidelity, naturalness and overall quality than the LEP filtered output image. The problem of using median filter is in the case of 3 dimensional images. Median filter can be used only for 1 dimensional and 2 dimensional image. Therefore, some mapping or conversion techniques are needed for the conversion of 3D image to 2D image. In future this conversion has to be made simple by using some simple mapping techniques. Then, the median filtered LEP can be used more effectively in various applications such as the processing of satellite images, 3D images and all.

REFERENCES

1. Wujing Li, Minyun Zhu, and Minghui Wang, “Local Edge-Preserving Multi scale Decomposition for High Dynamic Range Image Tone Mapping”, IEEE Trans. Image Process., vol. 22, no. 1, pp. 70-79, Jan. 2013.
2. J. M. DiCarlo and B. A. Wandell, “Rendering high dynamic range images”, Proc. SPIE, vol. 3965, pp. 392–401, May 2000.
3. R. Kimmel, M. Elad, D. Shaked, R. Keshet, and I. Sobel, “A variational framework for retinex”, Int. J. Comput. Vis., vol. 52, no. 1, pp. 7–23, 2003.
4. E. H. Land and J. J. McCann, “Lightness and retinex theory”, J. Opt. Soc. Amer., vol. 61, no. 1, pp. 1–11, Jan. 1971.
5. M. Elad, “Retinex by two bilateral filters”, in Proc. 5th Int. Conf. Scale Space PDE Methods Comput. Vis., vol. 3459, pp. 217–229, Apr.2005.
6. Z. Farbman, R. Fattal, D. Lischinski, and R. Szeliski, “Edge-preserving decompositions for multi-scale tone and detail manipulation”, ACM Trans. Graph., vol. 27, no. 3, pp. 1–10, Aug. 2008.
7. K. Subr, C. Soler, and F. Durand, “Edge-preserving multiscale image decomposition based on local extrema”, ACM Trans. Graph., vol. 28, no. 5, pp. 147–155, Dec. 2009.
8. G. Guarnieri, S. Marsi, and G. Ramponi, “High dynamic range image display with halo and clipping prevention”, IEEE Trans. Image Process., vol. 20, no. 5, pp. 1351–1362, May 2011.
9. R. Fattal, D. Lischinski, and M. Werman, “Gradient domain high dynamic range compression”, ACM Trans. Graph., vol. 21, no. 3, pp. 249–256, Jul. 2002.
10. F. Drago, W. L. Martens, K. Myszkowski, and N. Chiba, “Design of a tone mapping operator for high dynamic range images based upon psychophysical evaluation and preference mapping”, *Proc. SPIE*, vol.5007, pp. 321–331, Jun. 2003.

11. P. E. Debevec and J. Malik, "Recovering high dynamic range radiance maps from photographs", in Proc. SIGGRAPH, vol. 31, pp. 369–378, Aug. 1997.
12. S. Battiato, A. Castorina, and M. Mancuso, "High dynamic range imaging for digital still camera: An overview", J. Electron. Imag., vol. 12, no. 3, pp. 459–469, July 2003.
13. Z. Rahman, D. J. Jobson, and G. A. Woodell, "Retinex processing for automatic image enhancement", J. Electron. Imag., vol. 13, no. 1, pp.100–110, Jan.2004.
14. D. J. Jobson, Z. Rahman, and G. A. Woodell, "Properties and performance of a center/surround retinex", IEEE Trans. Image Process., vol. 6, no. 3, pp. 451–462, Mar. 1997.
15. Hojatollah Yeganeh,and Zhou Wang, "Objective Quality Assessment of Tone-Mapped Images", IEEE Trans. Image Process., vol. 22, no. 2, pp. 657-667, Feb. 2013.