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Removal of Ghost Artefacts for HDR Image

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Abstract

Abstract- this paper proposes an algorithm for the removal of ghost artefacts in order to yield a "high dynamic range" (HDR) image which is free from ghost artefacts which result because of camera's movement. The condition of working of current HDR images is that camera does not move during the acquisition of multiple "low dynamic range" (LDR) images. Such unrealistic restriction is overcome by specifying the target first and in an acquired set of LDR images, a source image is also specified and then estimation of rotational components and translational components is done in affine matrix for transforming the source image to fit into target image. The HDR image will be reconstructed by the proposed algorithm without having ghost artefacts as there is no camera movement in transformed images. The results show the successful removal of ghost artefacts. This is the reason which extends the application of proposed algorithm from HDR imaging to several devices of mobile imaging such as mobile phone camera and camcorder.

Keywords: *HDR, ghost artefacts, LDR, Exposure resolution, translational, rotational.*

I. INTRODUCTION

The last decade has "high dynamic range" (HDR) imaging as an active topic in the area of graphics and computer vision. The best approach for the generation of an HDR image is by the combination of different exposure of LDR images in a same scene[1][2]. The results of present HDR methods are promising but their application is limited to studio level ideal environment because of the static acquisition requirement. Or these methods are not able to get rid of ghost artefacts during the movement of a camera. But modern imaging devices need HDR without ghost artefacts that arise from dynamic acquisition. This work relates to the present research which combines different images of multiple exposure for producing clean and sharp image. Multiple photos can be combined for the creation of HDR image which assumes a still scene and a fixed camera[3]. Results are generalized by varying viewpoints[4][5]. The sharp and clean HDR images are produced by using "elastic registration(ER)" algorithm for exposing LDR images differently. It is used for minimizing geometric errors between LDR images[6]. The algorithm proposed here has a key advantage of being capable of generation of HDR images without the existence of ghost artefacts in the presence of moving camera. This is the reason which leads to the application of proposed algorithm to several imaging devices such as phone camera, handheld camera etc.

II. REGSITRATION OF LOW DYNAMIC RANGE IMAGE

An image registration algorithm is required for combining numerous LDR images without existence of ghost artefacts. The affine matrix is used for the registration of source image to target image by ER algorithm proposed by

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Periaswamy[6]. The LDR images are efficiently registered by assuming the rotational and translational motion in the movement of camera. Therefore, rotational and translational components are contained in affine matrix of ER algorithm. The LDR image (source) is denoted as $f(x,y,t)$and the target LDR image is denoted as $f(\hat{x},\hat{y},t-1)$ We assume the conserve image intensities between the images and an affine transform is used to model movemnt between LDR images.

$$f(x,y,t) = f(m_1x+m_2y+m_5, m_3x+m_4y+m_6, t-1)$$
(1)

Here, m_1, m_2, m_3 and m_4 denote the linear affine parameters and m_5, $m_6$denote translational parameters. The following quadratic equation is define to explain these parameters:

$$E(\vec{m}) = \sum_{x,y\in\Omega}\begin{bmatrix} f(x,y,t) \\ -f(m_1x+m_2y+m_5, m_3x+m_4y+m_6, t-1) \end{bmatrix}^2$$
(2)

Where

$\vec{m} = (m_1 \cdots m_6)^T$, here small spatial neighbourhood is denoted by Ω. It is not possible to minimize this error function analytically because of nonlinear unknowns of this error function[7]. The minimization is simplified by “first order truncated Taylor series expansion” for the approximation of error function as:

$$E(\vec{m}) \approx \sum_{x,y\in\Omega}\left(f(x,y,t) - \begin{bmatrix} f(x,y,t)+(m_1x+m_2y+m_5-x)f_x(x,y,t) \\ +(m_3x+m_4y+m_6-y)f_y(x,y,t)-f_t(x,y,t) \end{bmatrix}\right)^2$$
(3)

The spatial derivatives of f are $fx$and fy and the temporal derivative of f are ft. The error function is minimized as according to Taylor series:

$$E(\vec{m}) = \sum_{x,y\in\Omega}\left[k - \vec{c}^T\vec{m}\right]^2 \quad (4)$$

Where the scalar values are given as:

$$k = f_t + xf_x + yf_y ,$$

$$\vec{c} = \begin{pmatrix} xf_x & yf_x & xf_y & yf_y & f_x & f_y \end{pmatrix}^T \quad (5)$$

The differentiation is done with respect to an unknown value for minimizing this error function analytically:

$$\frac{dE(\vec{m})}{d\vec{m}} = \sum_{x,y\in\Omega} -2\vec{c}\left[k - \vec{c}^T\vec{m}\right]. \quad (6)$$

This result is set equal to zero and it is solved yielding the results:

$$\vec{m} = \left[\sum_{x,y\in\Omega}\vec{c}\vec{c}^T\right]^{-1}\left[\sum_{x,y\in\Omega}\vec{c}k\right] \quad 7)$$

The error function is more accurately estimated by performing Newton Raphson method of iteration. At each iteration, the estimate of transformation is implemented to LDR images of source and the estimation of new transformation is done between newly rotated and translated source and a target LDR image. The quantity of movement that is capable of being estimated can be restricted by providing required finite support by the spatial derivatives. To continue with larger motion, adoption of course to fine approach is done. The target and source images of LDR are built by Gaussian pyramid. The rotation and translation of source LDR image is done by affine parameters in pyramid’s next level[8][9].

III. EXPERIMENTAL RESULTS

The proposed method was verified for effectiveness by conducting various experiments by using various real images. The “Canon EOS-5D Mark II” was used for capturing the images. The images are reduced to as size of 640x840 for simplifying the processing. The comparison of results obtained by this experiment is done with those in Debevec’s method [3] and some of existing commercial products like Qtpfsgui and FDRTools.

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-2 EV 0 EV +2 EV

(a) The sequence of a car

-2 EV 0 EV +2 EV

(b) The sequence of a café

-2 EV 0 EV +2 EV

(c) The sequence of a Lamp

Fig. 1 Sequence of test with different values of exposure for LDR

Figure 1 illustrates the sequence of test with different “exposure values” (EVs). During the motion of camera and in the night time, test sequences are developed. The direction of movement of camera is represented by red arrow and the target LDR image is a 0 EV image[10]. The movement of camera is represented by a red arrow and a target LDR image in each sequence is represented by 0 EV.

Debevec’s method Qtpfsgui FDRTools Proposed algorithm

(a) HDR images using sequence of car images

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Debevec's method | Qtpfsgui | FDRTools | Proposed algorithm

(b) HDR images using sequence of café images

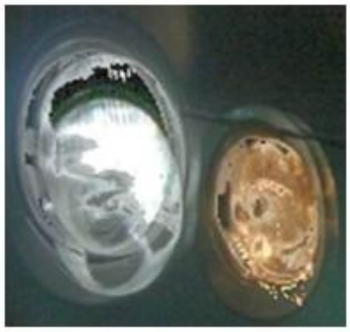
Debevec's method | Qtpfsgui | FDRTools | Proposed algorithm

(c) HDR images using sequence of lamp images

Fig. 2 Different sequences of test resulting HDR images

The "Debevec's method, Qtpfsgui, FDRTools, proposed algorithm" has been used for representing the HDR image in figure 2. The ghost artefacts are removed as a result of proposed algorithm. The license plate has been enhanced as a result of car sequence. The vehicles can be checked for crime related issues by the proposed algorithm as it is capable of removing ghost artefacts and the low illumination image is enhanced by it[11]. The cropping of test sequence is done and size of images is enlarged for getting clear comparison result as can be seen in figures.

(a) Detail region



(b) Debevec's method

(c) Qtpfsgui

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(d) FDR tools

(e) Proposed algorithm
Fig. 3 HDR images details (car sequence)

The areas of enlargement and crop are represented in figure 3(a), the HDR image results are represented in figure 3(b)-(e). The Debevec method's results are shown in fig. 3(b). The movement of camera is not compensated by this method, resulting in ghost artefacts in HDR images. The result of Qtpfsgui software is represented by fig. 3(c) and the result of FDR Tools software is represented by fig. 3(d). The ghost artefacts are improved by these methods but they still exist. But the accurate expressing of bright region's texture is not done. The results obtained from the proposed algorithm is represented in figure 3(e). The movement of camera is compensated by the registeration of LDR images by the algorithm proposed here. Also, the bright region's texture can be improved and removal of ghost artefacts can be done rather than fig. 3(c), 3(d). The results of comparison of HDR image is represented in figure 4.The ghost artefacts can be found as illustrated in fig. 4(b).The tone mapping error at the bright region is contained in figure 4(c) and the noise around edge is contained in figure 4(d). The 'ghost artefacts and noise around edge' is removed by the proposed algorithm.

(a)

(b) Debevec's method (c) Qtpfsgui

(d) FDR Tools (e) Proposed Algorithm

Fig. 4 Details from HDR images

The ghost artefacts are contained in figure 5(b), the expression of accurate color is done in figure 5(c) as it consist of tone mapping error. The ghost artefacts still exist in fig. 5(d) inspite of it being an improved version of ghost artefacts rather than fig. 5(b).

(a) Detail region

(b) Debevec's method (c) Qtpfsgui

(d) FDR Tools (e) Proposed algorithm

Fig. 5 HDR Image deatails (Lamp sequence)

The sum of movement between registered/unregistered LDR images is given in table 1. The motion of camera can be compensated by the reduction in motion difference between LDR imaegs by the algorithm proposed[12], [13].

Table 1 Comparison of movement between registered/unregistered frames

Sequence	Unregistered		Registered	
	Vertical	Horizontal	Vertical	Horizontal
Car	1734	1778	1316	1371
Café	1218	1789	704	612
Lamp	1790	1207	723	685

IV. CONCLUSION

This paper proposes an algorithm for the removal of ghost artefacts which is able to produce HDR image free from ghost effect when camera moves[14][15]. The current method of the generation of HDR image has a limitation of holding the camera still when LDR image is captured. This restriction is improved by proposing an algorithm which uses ER algorithm for registering LDR images for compensating the movement of camers. It is clearly understood from the results that the ghost artefacts are well removed by the proposed algorithm rather than Debevec's or other comemrcial methods. Because of this reason, mobile imaging devices such as camcorder and phone cameras are based on the proposed algorithm. The geometric parameters are estiamtedd iteratively which gives rise to the computational load in the proposed algorithm. The future work has to be done for the optimation of this proposed algorithm which leads to the reduction in the computational load and develops the algorithm which is able to do the compensation of zoom in/zoom out movement. The color distortion which occurs during tone mapping is enhanced by the color enhancement.

REFERENCES

[1] C. Barat and A. I. Comport, "Active high dynamic range mapping for dense visual SLAM," in *IEEE International Conference on Intelligent Robots and Systems*, 2017.

[2] R. K. Chaurasiya and K. R. Ramakrishnan, "High dynamic range imaging," in *Proceedings - 2013 International Conference on Communication Systems and Network Technologies, CSNT 2013*, 2013.

[3] P. E. Debevec and J. Malik, "Recovering high dynamic range radiance maps from photographs," in *Proceedings of the 24th annual conference on Computer graphics and interactive techniques - SIGGRAPH '97*, 1997.

[4] Seon Joo Kim and M. Pollefeys, "Radiometric alignment of image sequences," 2004.

[5] T. H. Oh, J. Y. Lee, Y. W. Tai, and I. S. Kweon, "Robust high dynamic range imaging by rank minimization," *IEEE Trans. Pattern Anal. Mach. Intell.*, 2015.

[6] S. Periaswamy and H. Farid, "Elastic registration in the presence of intensity variations," *IEEE Trans. Med. Imaging*, 2003.

[7] D. Boopathy and M. Sundaresan, "Enhanced encryption and decryption gateway model for cloud data security in cloud storage," in *Advances in Intelligent Systems and Computing*, 2015, vol. 338, pp. 415–421.

s[8] N. Saravanan, A. Mahendiran, N. Venkata Subramanian, and N. Sairam, "An implementation of RSA algorithm in google cloud using cloud SQL," *Res. J. Appl. Sci. Eng. Technol.*, 2012.

[9] Y. Yu *et al.*, "Cloud data integrity checking with an identity-based auditing mechanism from RSA," *Futur. Gener. Comput. Syst.*, 2016.

[10] P. Yellamma, C. Narasimham, and V. Sreenivas, "Data security in cloud using RSA," in *2013 4th International Conference on Computing, Communications and Networking Technologies, ICCCNT 2013*, 2013.

[11] R. Gharshi, "Enhancing Security in Cloud Storage using ECC Algorithm," *Int. J. Sci. Res.*, 2013.

[12] F. Moosmann and T. Fraichard, "Motion estimation from range images in dynamic

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outdoor scenes," in *Proceedings - IEEE International Conference on Robotics and Automation*, 2010, pp. 142–147.
[13] S. Hrabar, P. Corke, and M. Bosse, "High dynamic range stereo vision for outdoor mobile robotics," 2009, pp. 430–435.
[14] J. Zhang and J. F. Lalonde, "Learning High Dynamic Range from Outdoor Panoramas," in *Proceedings of the IEEE International Conference on Computer Vision*, 2017.
[15] L. M. Kaufman, "Data security in the world of cloud computing," *IEEE Secur. Priv.*, 2009.