Intelligent Detail Enhancement for Differently Exposed Images

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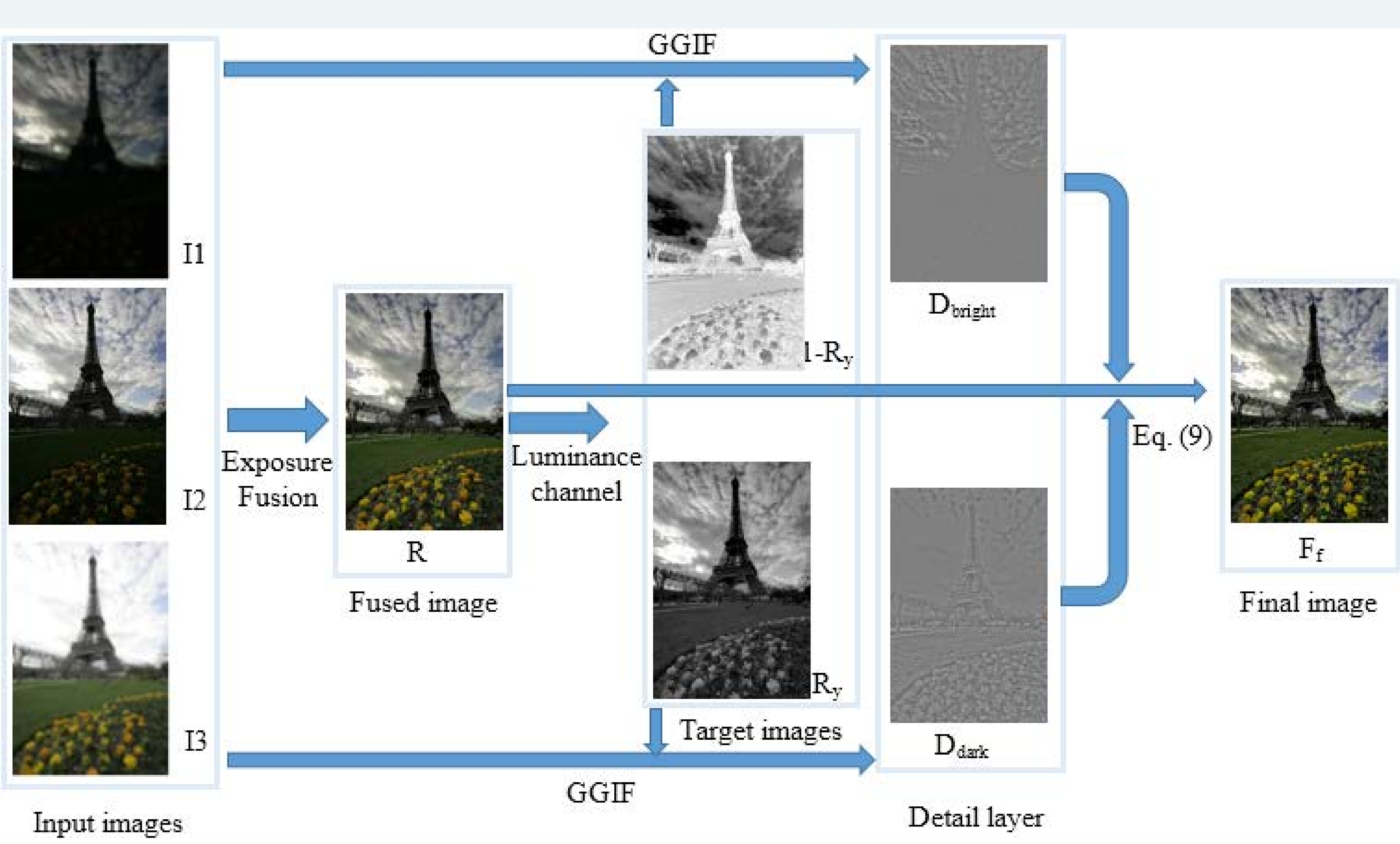
Introduction

Multi-scale exposure fusion is a fast approach to fuse several differently exposed images captured at the same high dynamic range (HDR) scene into a high quality low dynamic range (LDR) image. The fused image is expected to include all details of the input images, however, the details in the brightest and darkest regions are usually not preserved well. Adding details that are extracted from the input images to the fused image is an efficient approach to overcome the problem. In this paper, a fast selectively detail enhancement algorithm is proposed to extract the details in the brightest and darkest regions of the HDR scene and add the extracted details to the fused image. Experimental results show that the proposed algorithm can enhance the details of the fused image much faster than the existing algorithms with comparable or even better visual quality.

Flowchart



An improved GGIF

Let I(p) be an image to be smoothed, I'(p) be the smoothed image. T(p) be an tagr image who can control the ratio of gradient in the output and input images. The cost function of the proposed filter is

$$E(p) = \sum_{p \in \Omega_\zeta(p')} [((a_{p'} - 1)I(p) + b_{p'})^2 + \lambda(a_{p'} - T_{p'})^2]$$

And the solution is

$$a_{p'} = \frac{\sigma_I^2(p') + \lambda \cdot T_{p'}}{\sigma_I^2(p') + \lambda},$$
$$b_{p'} = (1 - a_{p'})\mu_I(p'),$$

The filtered image I'(p) is obtained by

$$I'(p) = \bar{a}_p I(p) + \bar{b}_p$$

Detail Enhancement using the GGIF

Let the differently exposed images be denoted as I_k, I_1 is the darkest one and In is the brightest one. The fused image can be obtained by using the exposure fusion algorithm in [1]. Let the fused image be denoted as *R*, and let R_y be the *Y* channel of *R*, i.e. the luminance channel of *R*. The luminance channels of I_1 and I_k are also calculated and denoted as I_1^y and I_k^y, respectively. The detail layer of I_1^y and I_k^y can obtained using the proposed improved GGIF with *1-* R_y and R_y severing as target image respectively. The detail enhanced luminance channel is

$$R'_y = R_y + \theta(D_{bright} + D_{dark}).$$

Experimental Results

The resultant images generated by [1], [2], [3] and the proposed algorithms are given below

The computation time of [1] and the added enhancement time cost of [2], [3] and the proposed algorithm are given below

Table 1. Comparison of Computational Time (second).

Set	Input Image Size	[1]	[2]	[3]	Proposed
1	808*600*7	2.45	+19.96	+36.54	**+0.42**
2	800*532*3	1.04	+17.40	+20.56	**+0.38**
3	1025*769*9	4.66	+38.71	+82.82	**+0.69**
4	2128*1416*5	8.48	+146	+244	**+2.67**

References

[1] T. Mertens, J. Kautz, and F. V. Reeth, "Exposure fusion: a simple and practical alternative to high dynamic range photography", *Computer Graphics Forum*, Vol. 28, pp.161-171, 2009.

[2] Z. G. Li, J. H. Zheng, and S. Rahardja, "Detail-enhanced exposure fusion", *IEEE Trans. on Image Processing*, vol. 21, no 11, pp. 4672-4676, Nov. 2012.

[3] F. Kou, Z. G. Li, C. Y. Wen, and W. H. Chen, "L0 Smoothing Based Detail Enhancement for Fusion of Differently Exposed Images", *8th IEEE Conference on Industrial Electronics and Applications (ICIEA 2013)*, June 2013, pp. 1398-1403.