Poisson Compositing (sap_0066)

Shanmuganathan Raman and Subhasis Chaudhuri
Indian Institute of Technology Bombay, India
{shanmuga,sc}@ee.iitb.ac.in

1 Introduction

Most of the real world scenes have a very high dynamic range. However the common capture and display devices can handle only a limited dynamic range. General approach to solve this problem is to use multi-exposure images and composite them in the irradiance domain to get a High Dynamic Range (HDR) image [Reinhard et al. 2005]. The generated image will be able to represent the real world scene faithfully. However, it needs to be tone-mapped to a Low Dynamic Range (LDR) image for visualization in common displays and printers. Generation of the high-quality LDR image of the scene directly from multi-exposure images even in the absence of any knowledge of camera response function and the exposure settings of the camera is of interest to graphics community. We propose a gradient domain compositing technique to solve the above problem and call it Poisson Compositing. We compare the proposed methodology with similar existing techniques and show that the proposed method is very fast and accurate.

2 Proposed Approach

We propose to solve the HDR imaging problem in the gradient domain. We composite gradients of the multi-exposure images to achieve seam-less blending. Given a set of multi-exposure images, we subject their gradients to an illumination change function specified in [Perez et al. 2003]. This operation is performed to brighten the less exposed images and darken the more exposed images as a pre-processing operation. We modify the gradient using $G_i'(x,y) = \left(\frac{0.2\times\alpha_i}{|\nabla f_i(x,y)|}\right)^{\beta_i} G_i(x,y)$, where α_i is the mean gradient magnitude, $G_i(x,y)$ is the gradient vector of the ith image $f_i(x,y)$, and β_i is a real number signifying the relative exposure time corresponding to each image. As exposure times are not known, we uniformly sample the range $[-0.2, 0.2]$ equalling the number of multi-exposure images and assign them as values for β_i from high to low exposures.

After the pre-processing step, we composite the modified gradients $G_i'(x,y)$ using the weighting function $w_i(x,y) = \gamma\Big(b_i(x,y) + c_i(x,y)\Big) + (1-\gamma)\Big(b_i(x,y)c_i(x,y)\Big)$, where $0 \leq \gamma \leq 1$, $b_i(x,y) = e^{\frac{-(f_i(x,y)-\mu)^2}{2\sigma^2}}$ is the brightness term used to provide less weight to over-exposed and under-exposed regions, and $c_i(x,y)$ is the normalized contrast term which equals the local mean of the gradient magnitude. The parameters μ and σ are assigned values 128 and 50 respectively. Having obtained the composited gradient field, we solve the resultant Poisson equation to obtain the scalar field (LDR image) using Neumann boundary conditions. We employ direct Poisson solver for our task as it is the fastest solver available.

There are many recent approaches which can composite multi-exposure images and produce a LDR image: variational compositing ([Raman and Chaudhuri 2007]), exposure fusion ([Mertens et al. 2009]), and bilateral compositing ([Raman and Chaudhuri 2009]). These methods assume no knowledge of camera response function and exposure times. However, these methods tend to produce a final image which does not preserve the contrast compared to that of the corresponding HDR image. However, since our approach performs compositing in the gradient domain, there is lesser loss of contrast and we obtain seam-less blending. The results of our approach along with that of the exisiting methods are as shown in Figure 1.

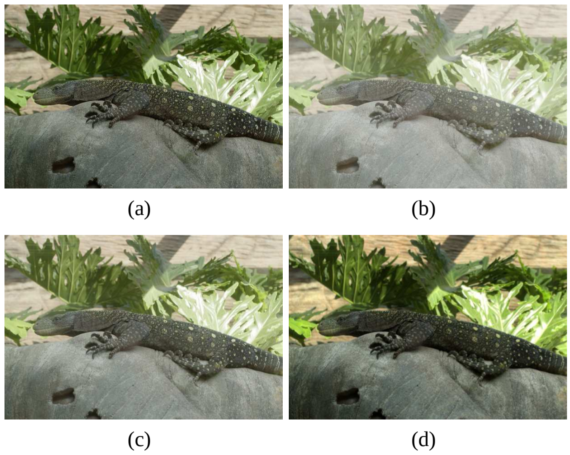

Figure 1: Results of (a) [Raman and Chaudhuri 2007], (b) [Mertens et al. 2009], (c) [Raman and Chaudhuri 2009], and (d) the proposed approach. Images Courtesy: Erik Reinhard, University of Bristol.

For compositing 9 images of size 2464 X 1632 in an Intel Xeon machine with 4 GB RAM, variational compositing took more than 15 minutes, exposure fusion took 107 seconds, bilateral compositing took 160 seconds, while the proposed approach took 113 seconds.

3 Conclusion

We have proposed an effective compositing technique for multi-exposure images, which are obtained by a digital camera utility such as auto-exposure bracketting (AEB), in the gradient domain. Obtained results show that our approach is very fast, apart from producing high quality LDR images.

References

MERTENS, T., KAUTZ, J., AND REETH, F. V. 2009. Exposure fusion: A simple and practical alternative to high dynamic range photography. *Computer Graphics Forum 28*, 1, 161–171.

PEREZ, P., GANGNET, M., AND BLAKE, A. 2003. Poisson image editing. *ACM Transactions on Graphics 22*, 3, 313–318.

RAMAN, S., AND CHAUDHURI, S. 2007. A matte-less, variational approach to automatic scene compositing. In *ICCV*, IEEE, 1–6.

RAMAN, S., AND CHAUDHURI, S. 2009. Bilateral filter based compositing for variable exposure photography. In *Short Papers*, Eurographics, 1–4.

REINHARD, E., WARD, G., PATTANAIK, S., AND DEBEVEC, P. 2005. *High Dynamic Range Imaging: Acquisition, Display and Image-Based Lighting*. Morgan Kaufmann Publishers.