Reconstructing HDR Images using Non-Learning and Deep Learning Based Multi-exposure Image Synthesis Techniques

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Motivation

- High dynamic range (HDR) imaging aims to present a greater range of luminance that is similar to that experienced by the human visual system. Its applications include VR, autonomous vehicles, and photography.
- Non-learning based HDR synthesis algorithms find the best weights to fuse multi-exposure low dynamic range (LDR) images. We adapted from Debevec's algorithm[1] and utilized a different fusion technique for luminance and chroma channels respectively.
- Different learning models (CNN, GAN[2], meta-learning[3]) have been used for multi-exposure image synthesis. We selected U-Net as the backbone architecture and studied the effect of various training schemes (optimizer, loss, and regularization) on the image fusion results.

Related Work

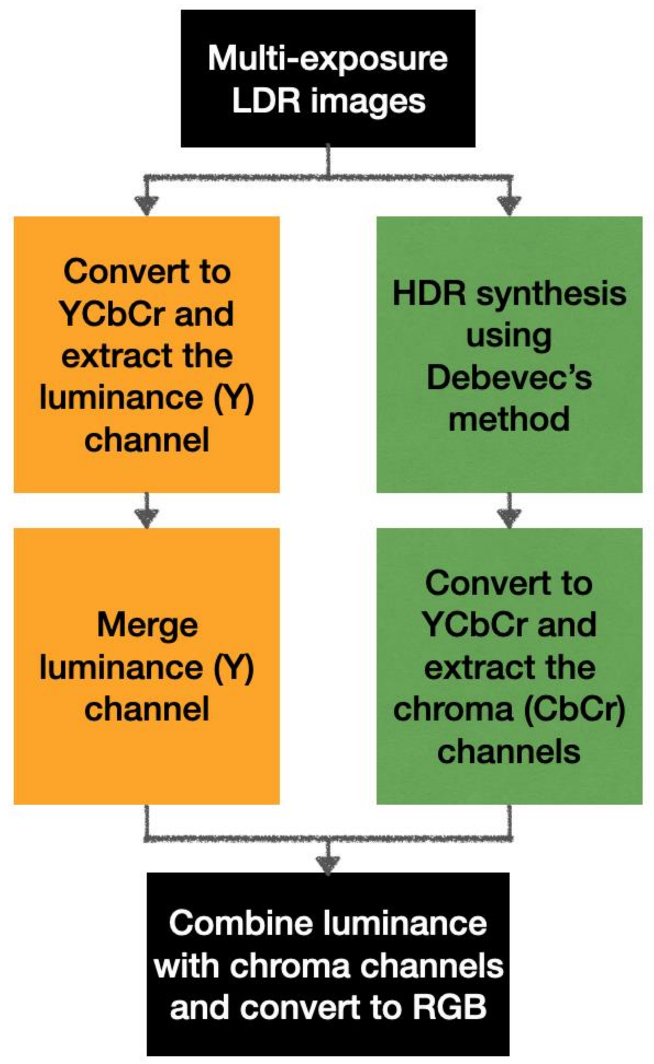
- Debevec's algorithm[1] fuses multiple LDR images by weighting more on pixels with values closer to the center of dynamic range at each exposure. Another hybrid fusion method[4] calculates weights differently for the luminance and chroma channels. Both methods are limited in the sense that they require more information, such as exposure time., on the input images
- Learning methods for LDR-HDR conversion require output reconstruction to full image size. To satisfy such requirement, U-Net is a good candidate model for its compact, symmetric encode-decoder style architecture. No additional information other than LDR input and HDR ground truth is needed.

References

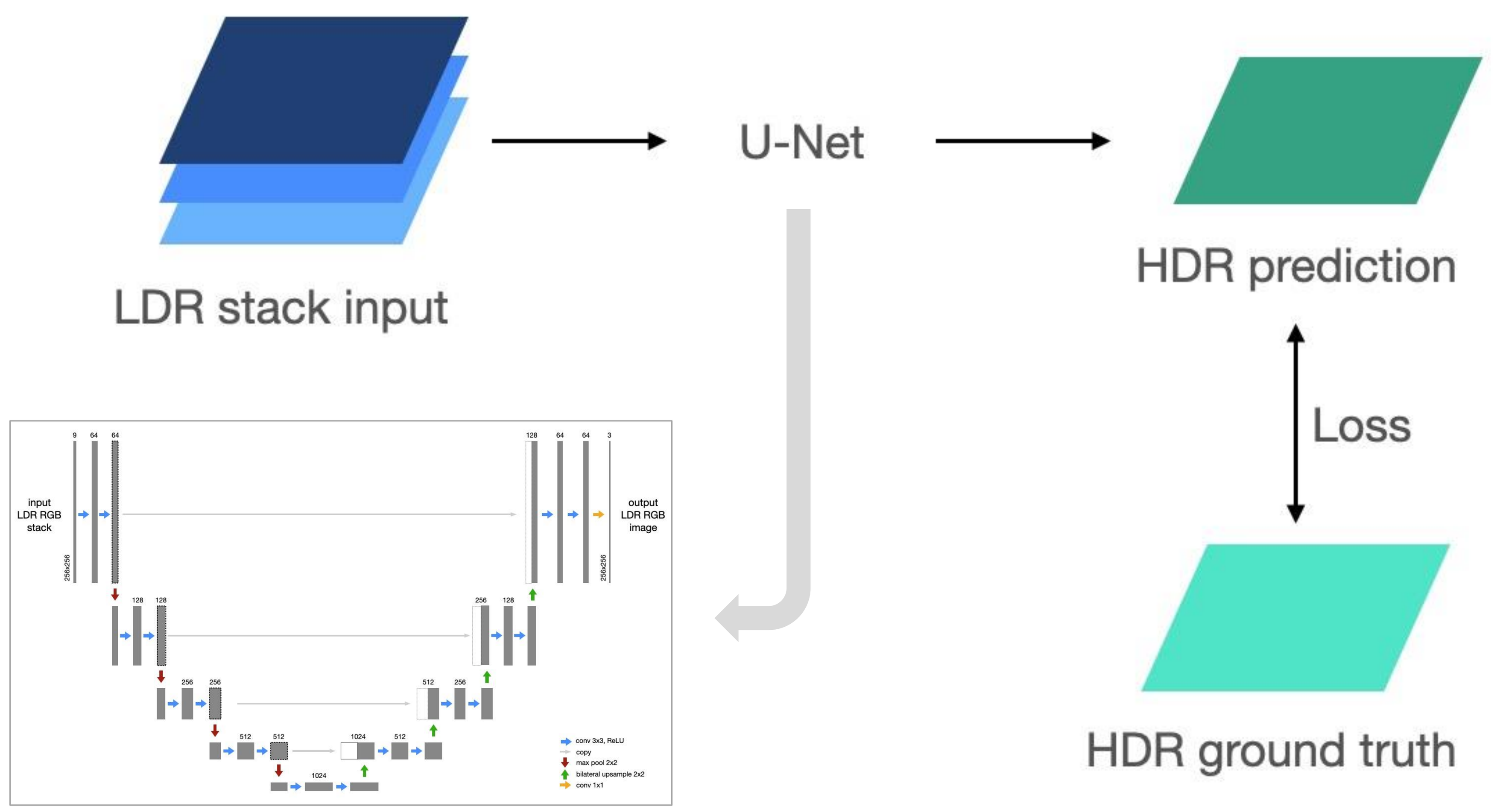
[1] P. E. Debevec and J. Malik, "Recovering high dynamic range radiance maps from photographs," in Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques, ser. SIGGRAPH '97.
[2] H. Xu, J. Ma, and X.-P. Zhang, "Mef-gan: Multi-exposure image fusion via generative adversarial networks," IEEE Transactions on Image Processing, vol. 29, pp. 7203–7216, 202
[3] E. Pan and A. Vento, "Metahdr: Model-agnostic meta-learning for hdr image reconstruction," March 2021.
[4] I. Merianos and N. Mitianoudis, "A hybrid multiple exposure image fusion approach for hdr image synthesis," in 2016 IEEE International Conference on Imaging Systems and Techniques (IST), 2016, pp. 222–226

New Technique

Non-learning based method



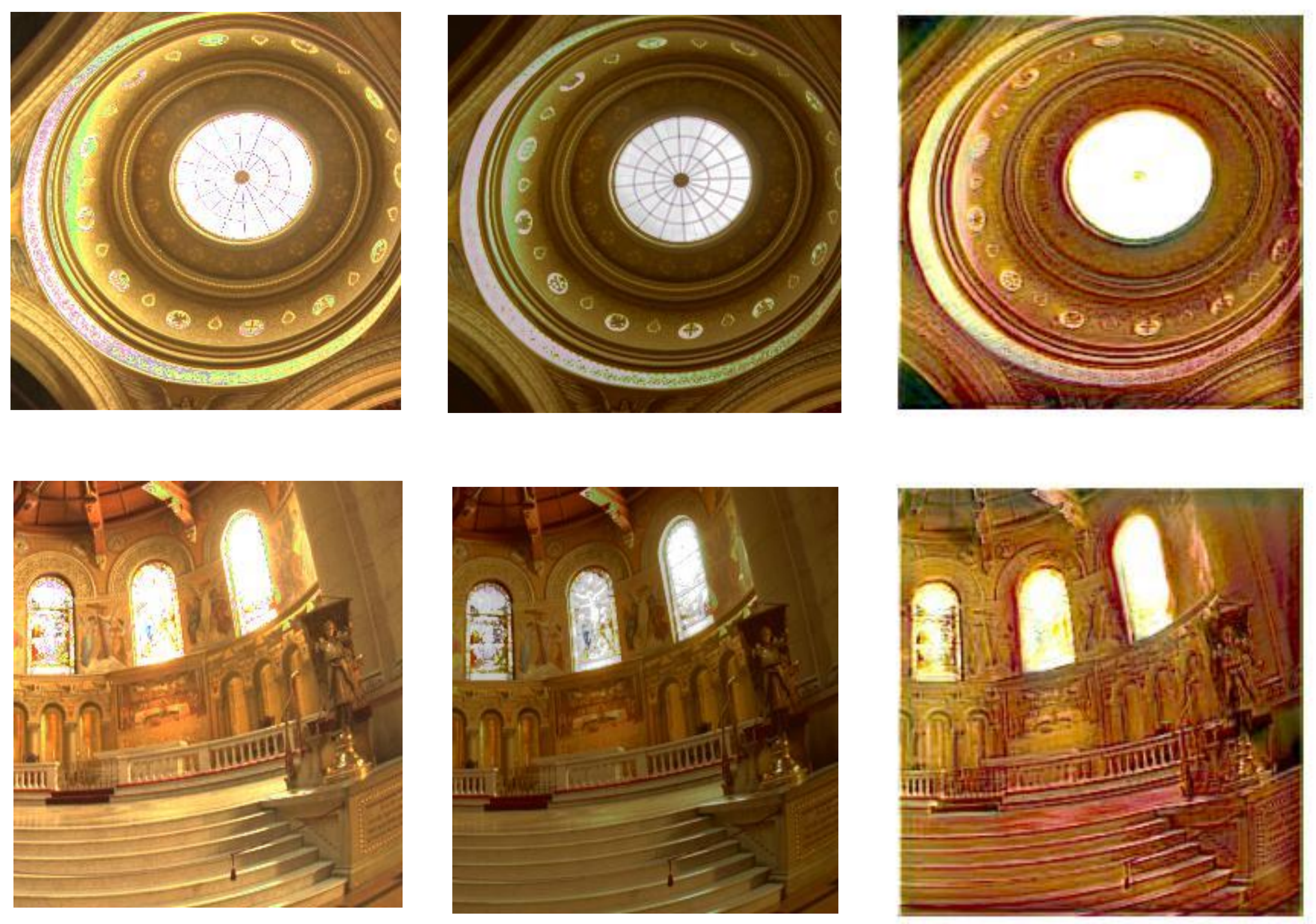
Deep learning based method



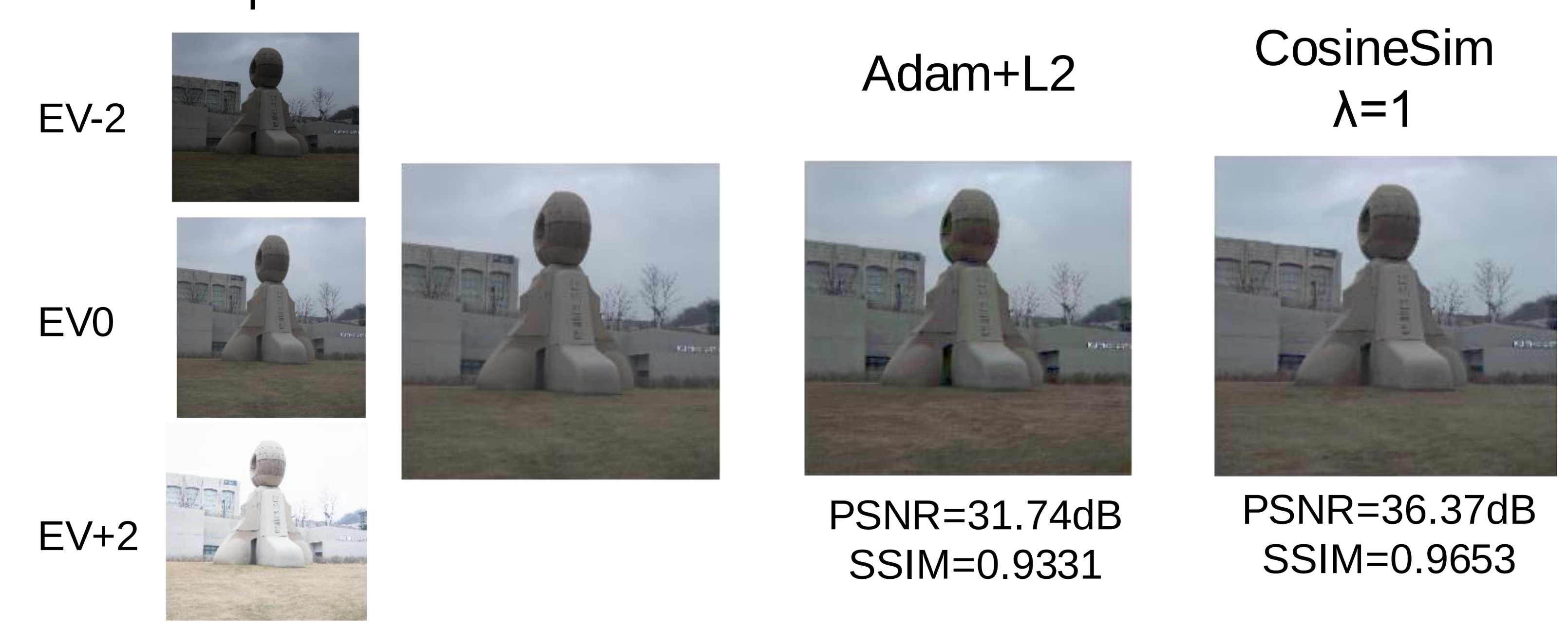
Experimental Results

Comparison of HDR results

Debevec's Algo | Non-learning based | Deep learning based



Deep learning based method



Comparison of PSNR (dB) for different objective functions and optimizers

	λ=0.0001	λ=0.001	λ=0.01	λ=1
TV	10.58	**10.87**	10.82	9.32

	SGD	Adam
L1	16.90	22.70
L2	14.91	**22.75**

	λ=0.05	λ=0.2	λ=0.5	λ=1	λ=1.5
Cosine Similarity	22.56	22.40	23.42	**23.66**	22.09