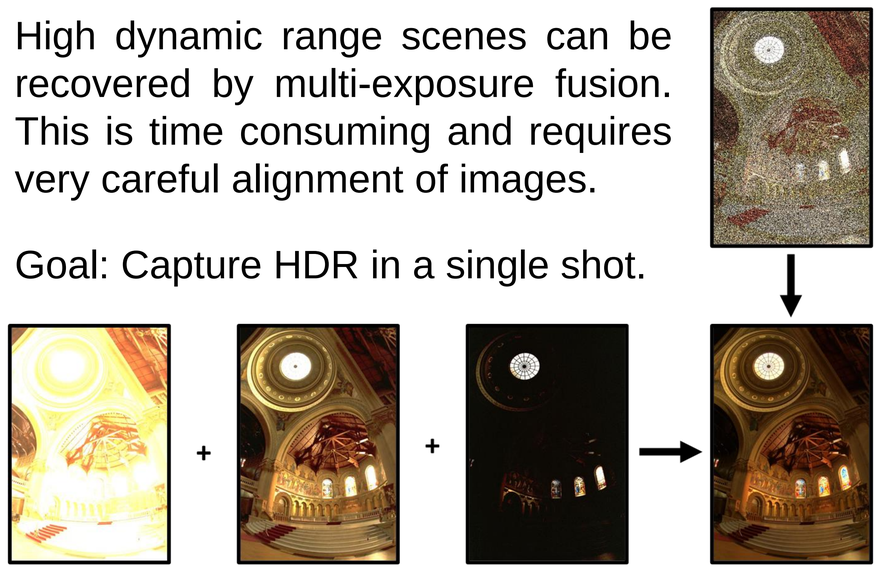
Single Shot HDR Imaging via Compressed Sensing

Matthew A. McCready
Department of Electrical Engineering, Stanford University

Motivation

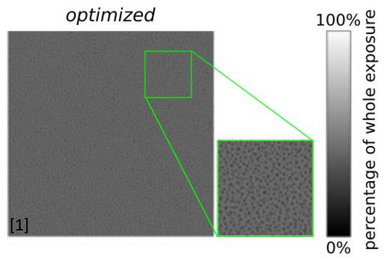
High dynamic range scenes can be recovered by multi-exposure fusion. This is time consuming and requires very careful alignment of images.

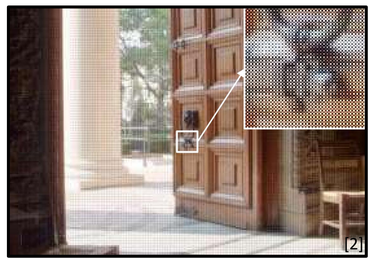
Goal: Capture HDR in a single shot.



Related Work

Single-shot HDR can be acquired with a spatially varying exposure.





Neural nets are limited by specific training mask and react unpredictably to change. Interpolation is limited by loss of high frequency details.

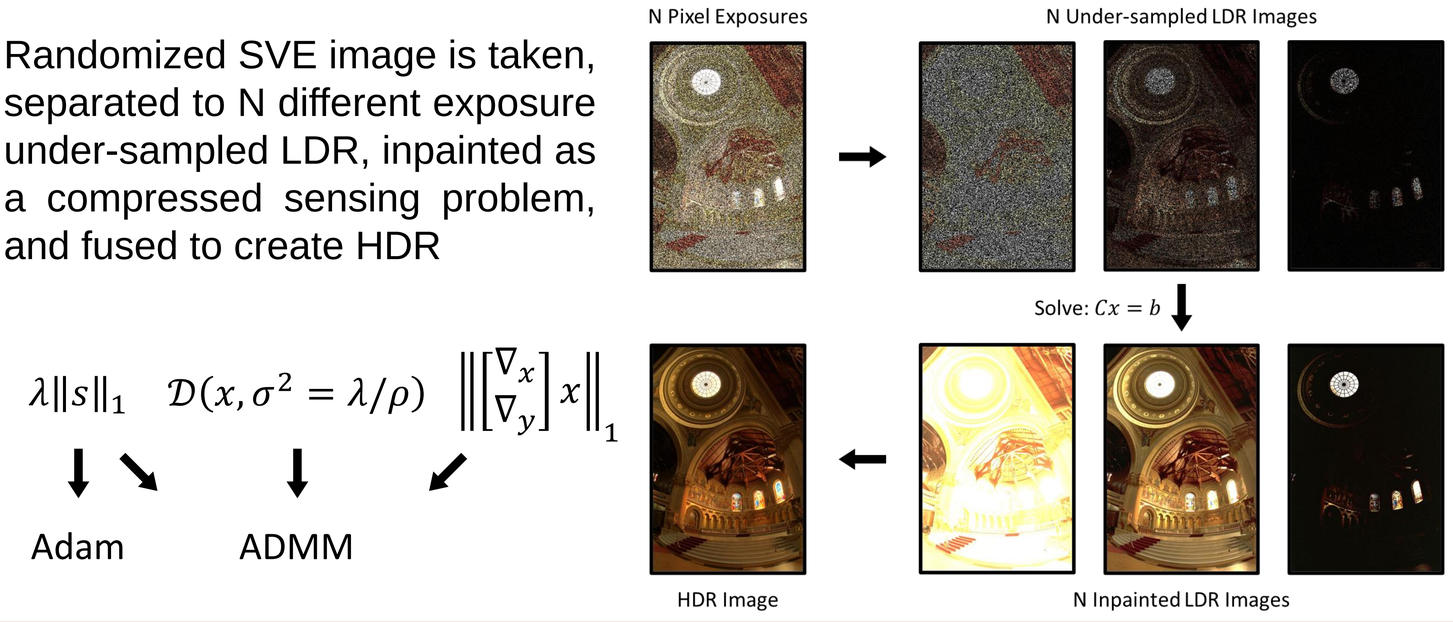
Compressed sensing can recover regions of rapid change better than interpolation. [3]

References

[1] Martel et al, Neural Sensors: Learning Pixel Exposures for HDR Imaging and Video Compressive Sensing with Programmable Sensors, IEEE Trans. Pattern Anal. Mach. Intell., 2020
[2] Nayar et al, High dynamic range imaging: spatially varying pixel exposures, Proceedings IEEE Conference on Computer Vision and Pattern Recognition, 2000
[3] Usman et al, Comparison of Classical Interpolation Methods and Compressive Sensing for Missing Data Reconstruction, IEEE International Conference on Signals and Systems, 2019
[4] Merianos et al, A Hybrid Multiple Exposure Image Fusion Approach for HDR Image Synthesis, IEEE International Conference on Imaging Systems and Techniques, 2016
[5] Mertens et al, Exposure Fusion, Pacific Conference on Computer Graphics and Applications, 2007.

Methods

Randomized SVE image is taken, separated to N different exposure under-sampled LDR, inpainted as a compressed sensing problem, and fused to create HDR



Results

Inpainting Convergence Results:

- L1 and DnCNN solvers converged fastest with a zero-order hold initial condition
- TV converged fastest with constant initial conditions
- DnCNN prior performed best, TV fastest

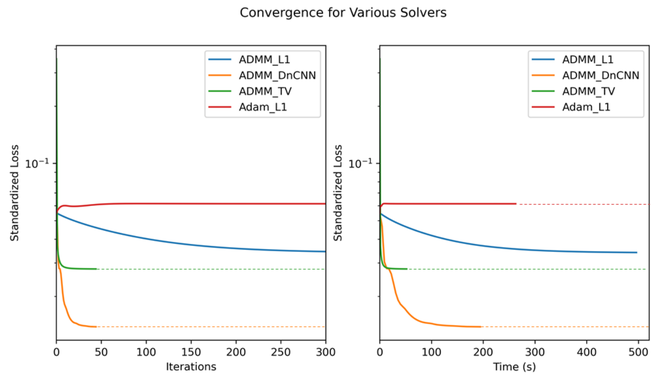
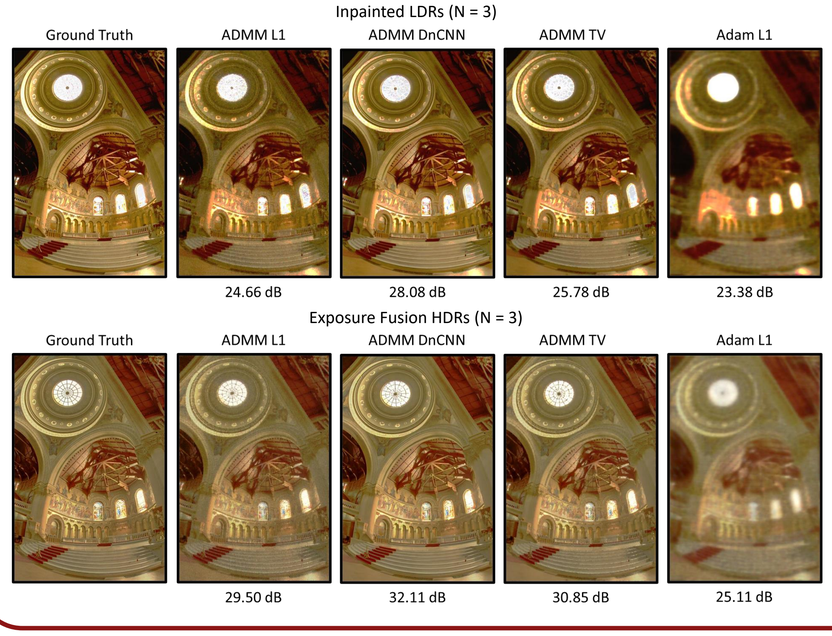


Image Results:

- DnCNN prior gives highest PSNR
- Capable of more exposures



Additional DnCNN HDR Results