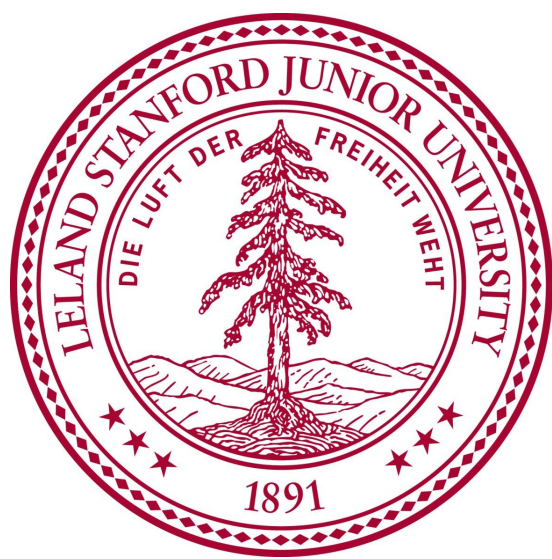




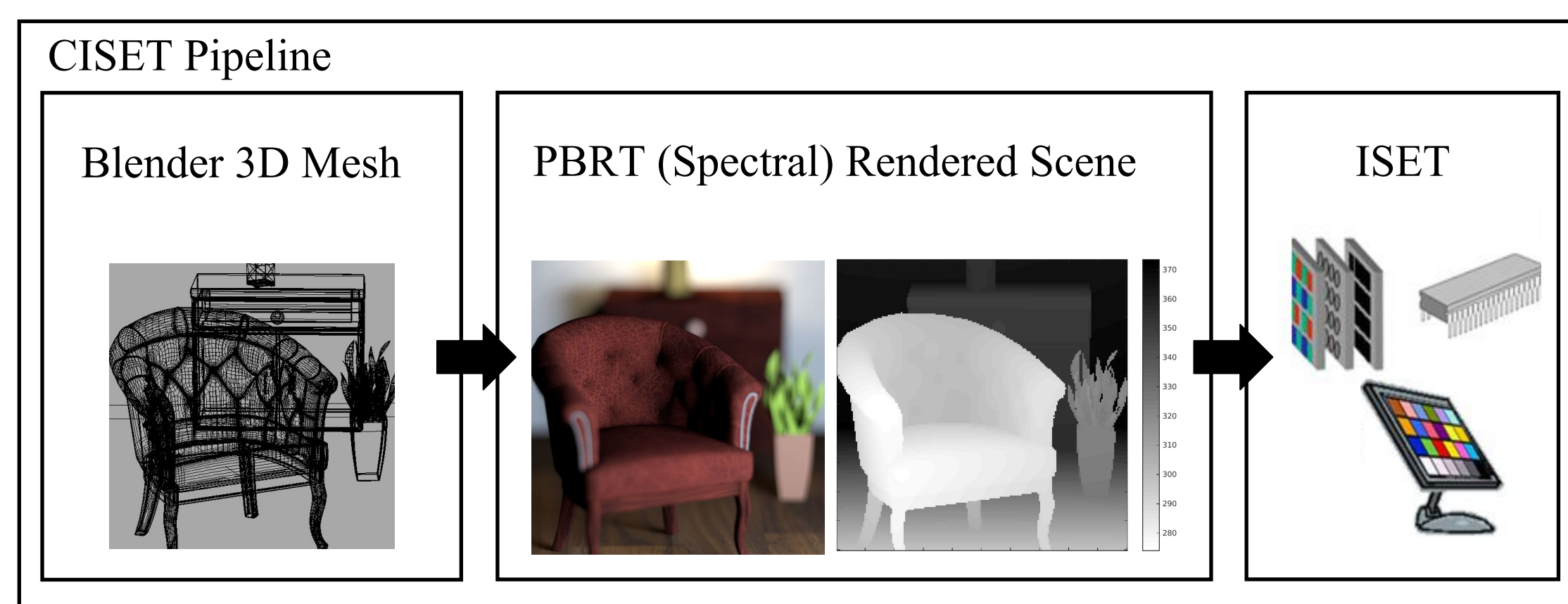
Demosaicing and Denoising Simulated Light Field Images

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EE 367: Professor Gordon Wetzstein

Motivation

- We try demosaicing and denoising simulated light field data using optimization techniques
- We assume a TV-prior over the four light field dimensions
- With simulation, we can calculate PSNR values relative to the true full color, no-noise image
- We try our method with different simulated illumination levels

Light Field Simulation



SIMULATION PARAMETERS	
Optical Image	
Rows/Cols	4500, 4500
Resolution (um/sample)	1.5, 1.5
Mean illuminance (lux)	12
Optics	
Name	dgauss.50mm.dat
Film distance (mm)	45
F-number	2.8
Aperture Diameter (mm)	1.2
Light Field	
Microlens (rows, cols)	500, 500
Microlens F-number	2.8
Microlens Aperture Diameter (um)	15.3
Sensor	
Pixel width/height (um)	1.7
Size width/height (mm)	6.7
Exposure (s)	1/90

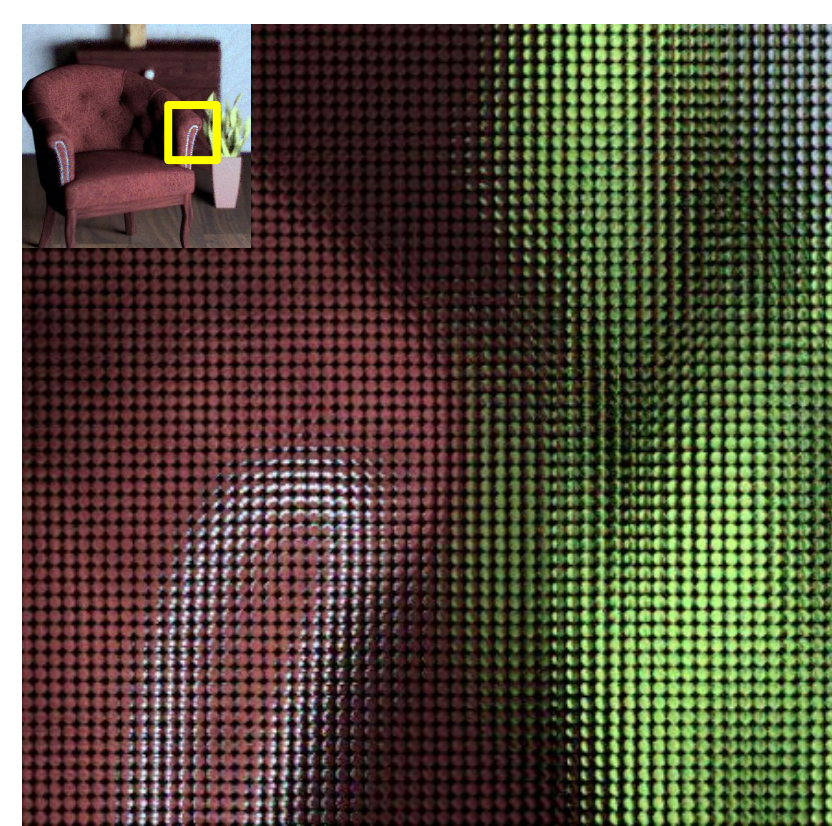
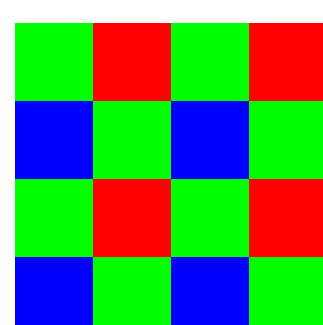
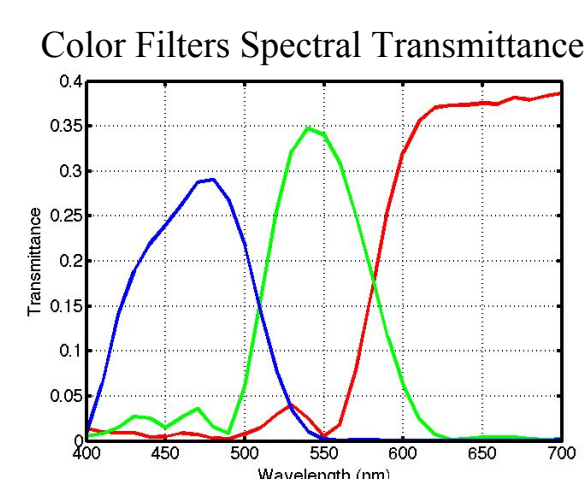
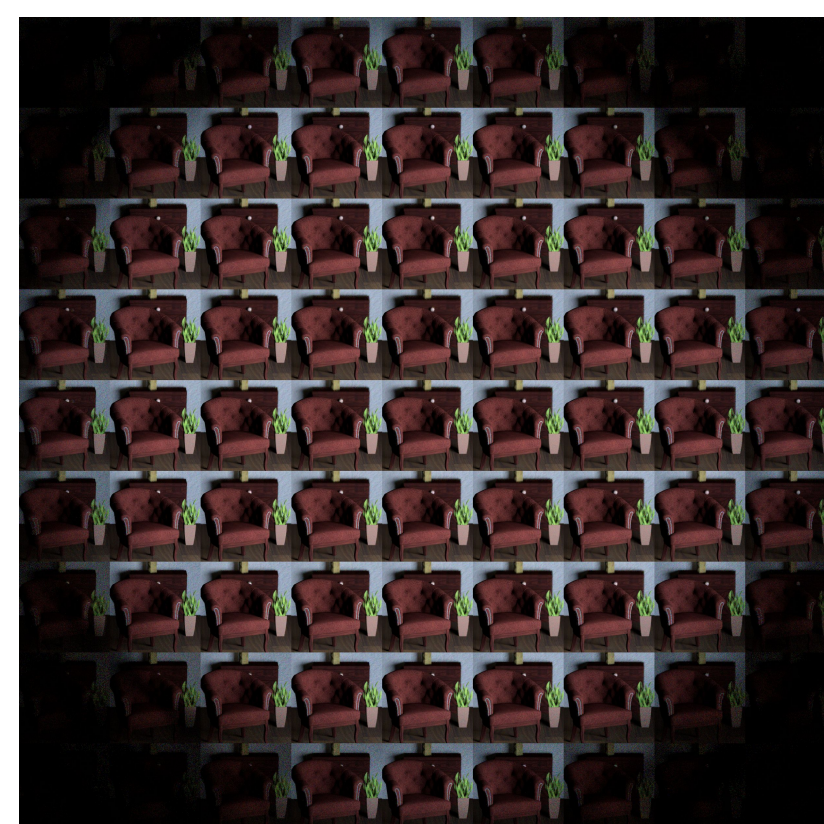
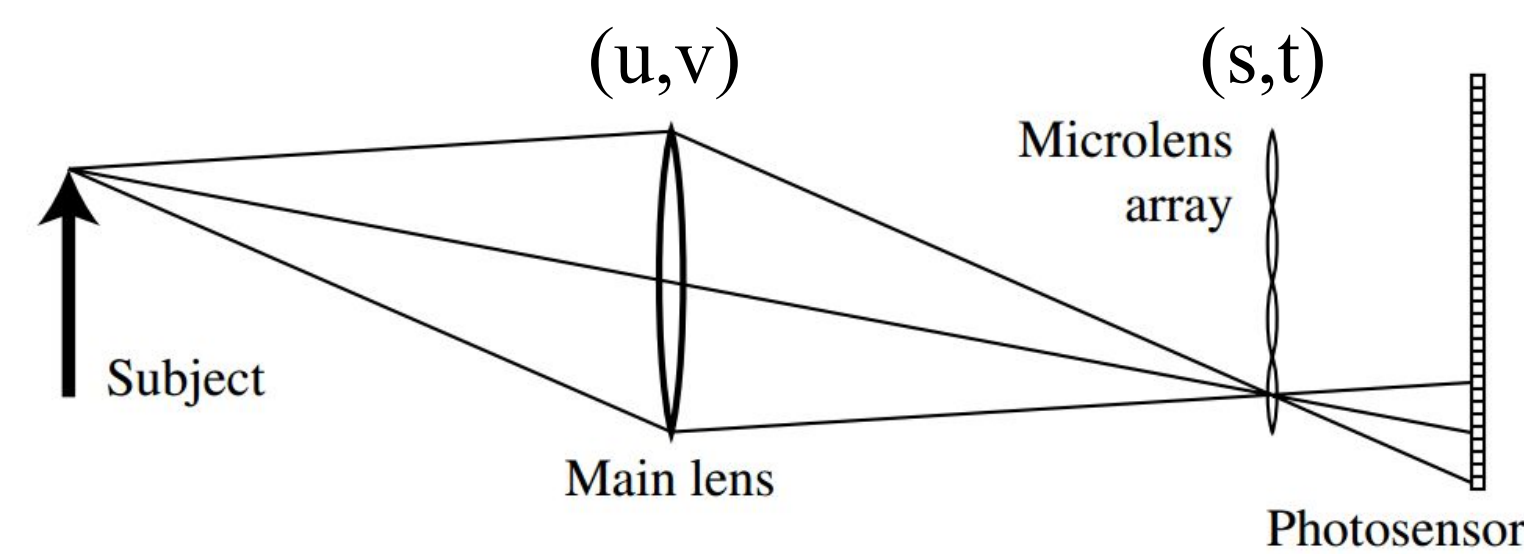


Image seen through microlens (s,t)



Sub-aperture Images (u,v)



General schematic of a light field camera [2]

Method

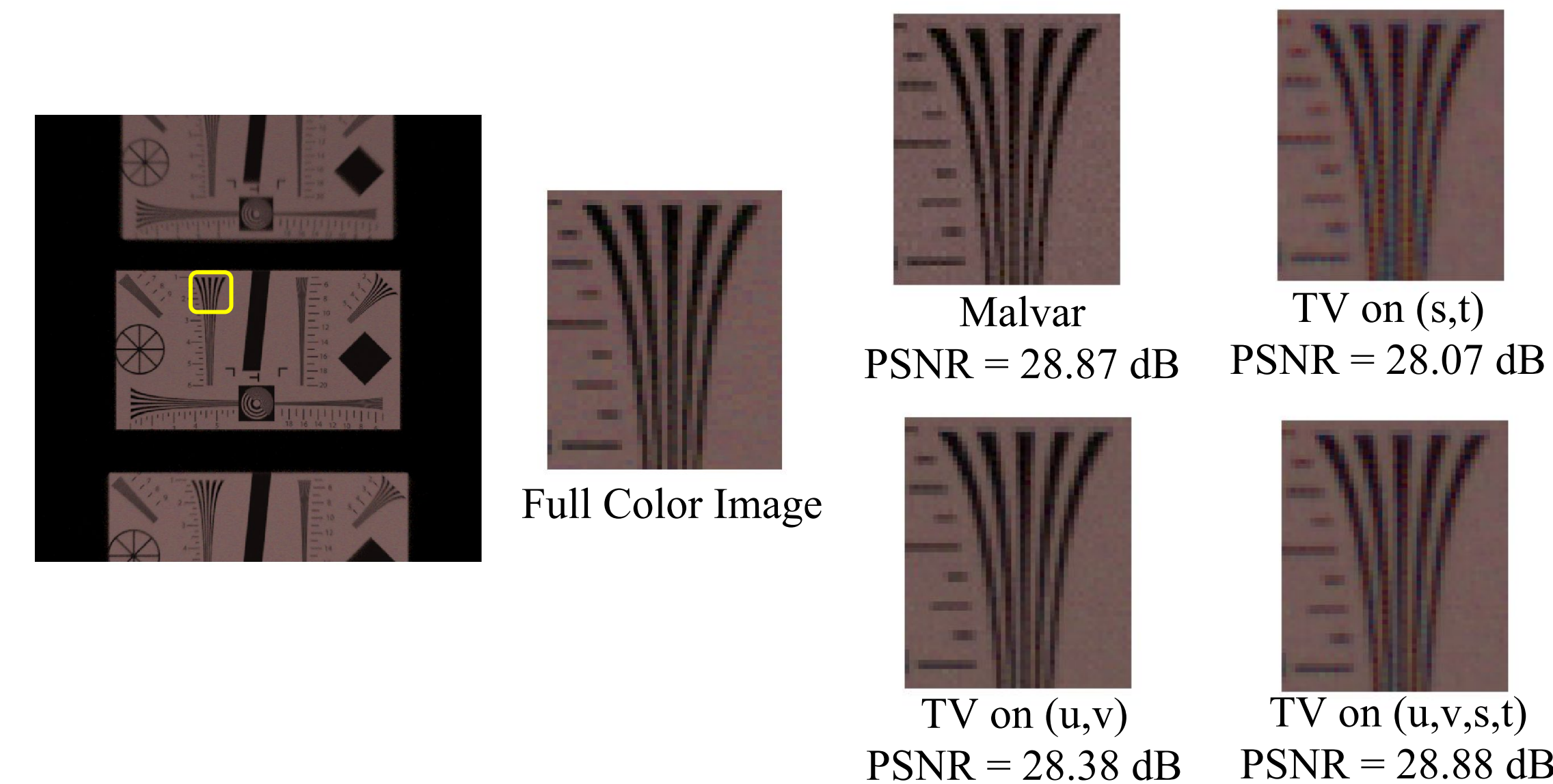
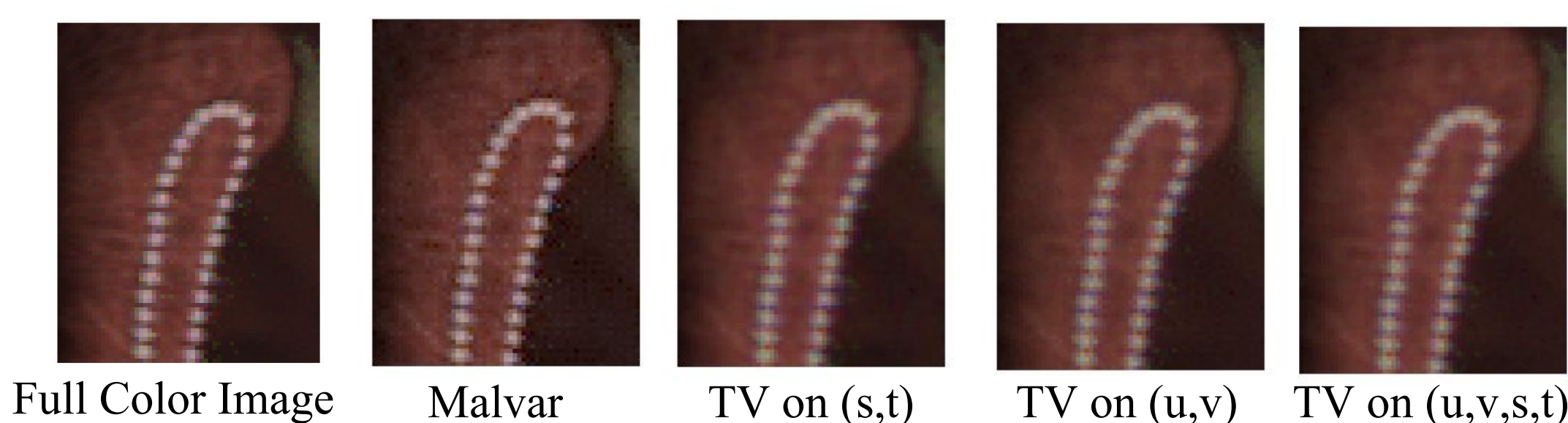
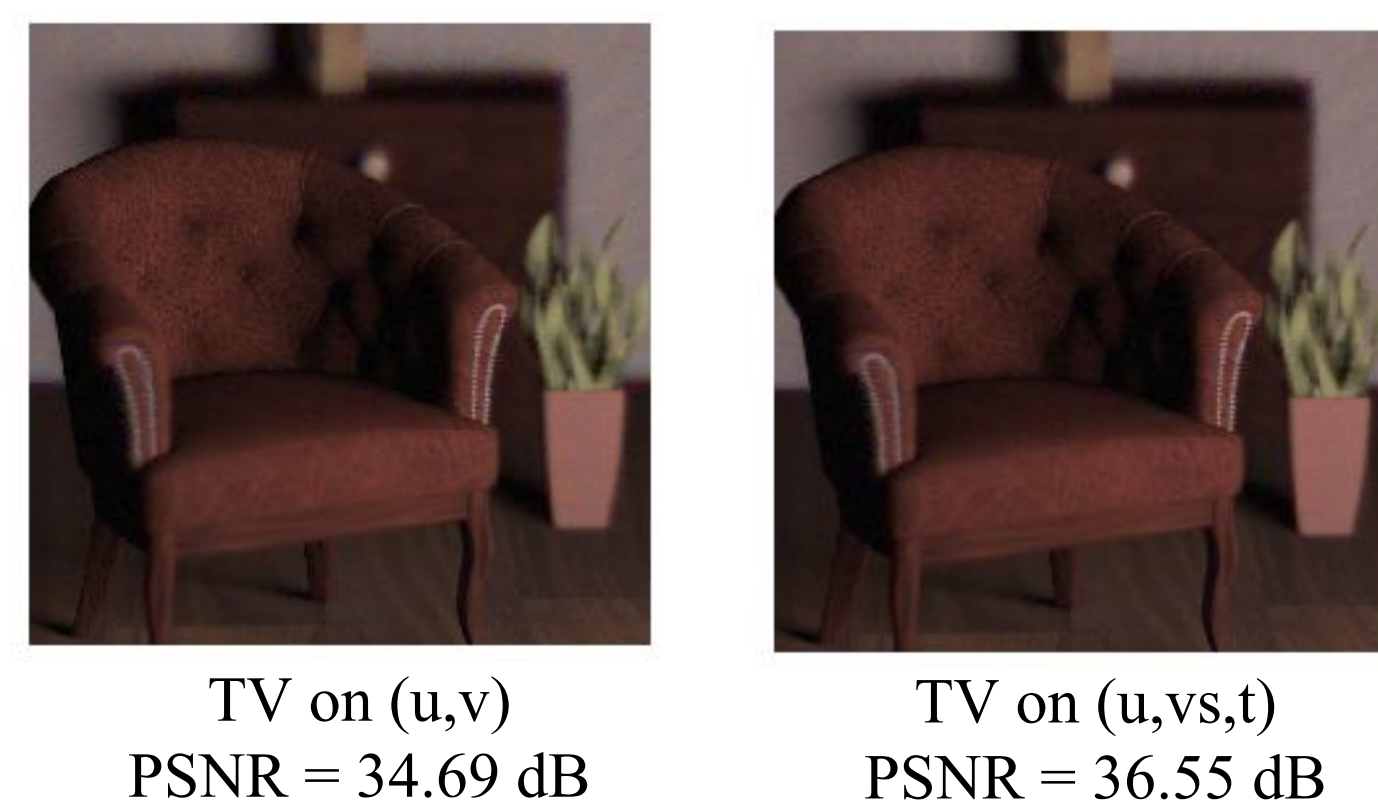
1. Malvar et al. [3] demosaicing on sensor image
2. Use ADMM to solve demosaicing/denoising problem with a total variation (TV) prior on:
 - a. u,v dimensions
 - b. s,t dimensions
 - c. u,v,s,t dimensions

$$\underset{\{x\}}{\text{minimize}} \quad \frac{1}{2} \|\mathbf{Ax} - \mathbf{b}\|_2^2 + \lambda \|\mathbf{Dx}\|_1$$

Image Processing Pipeline

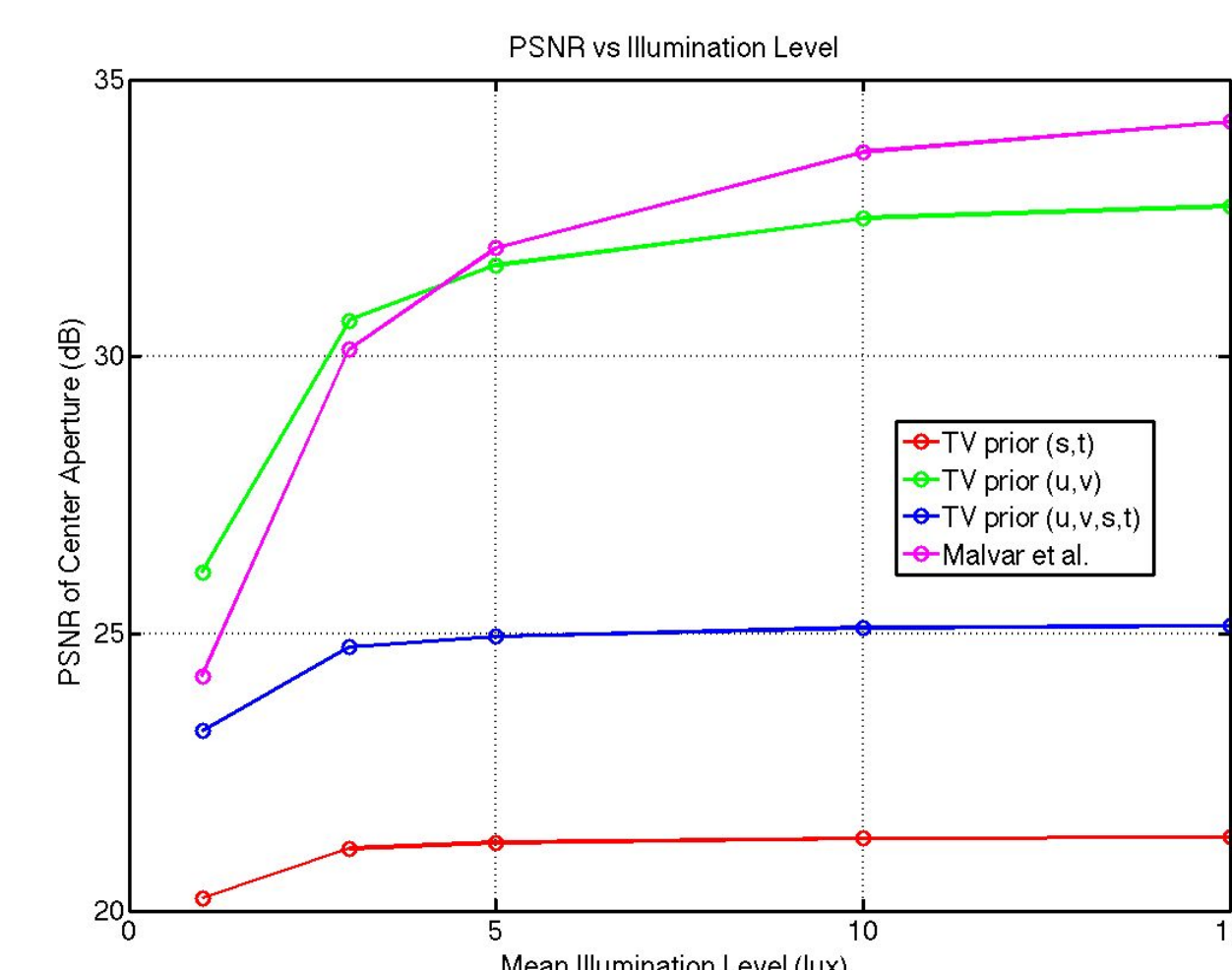
Raw Image → Demosaicing → Denoising → Gamut Mapping → Compression

Results

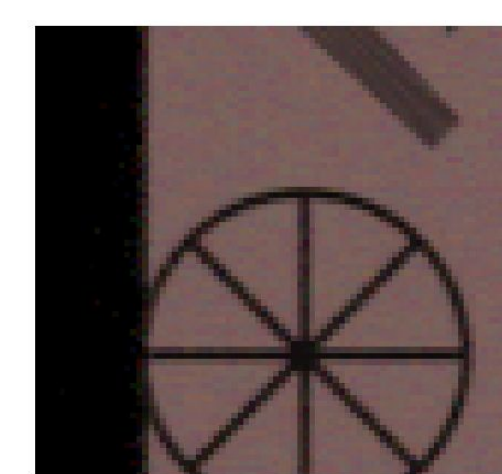
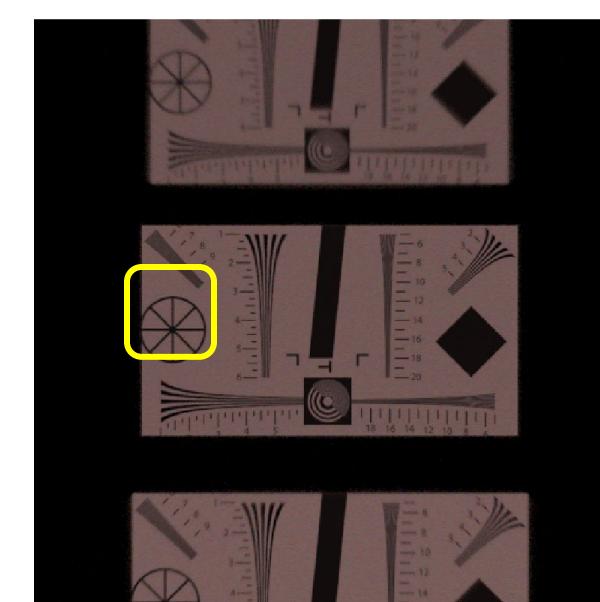


Changing Illumination Levels

- Low illumination generates more noise

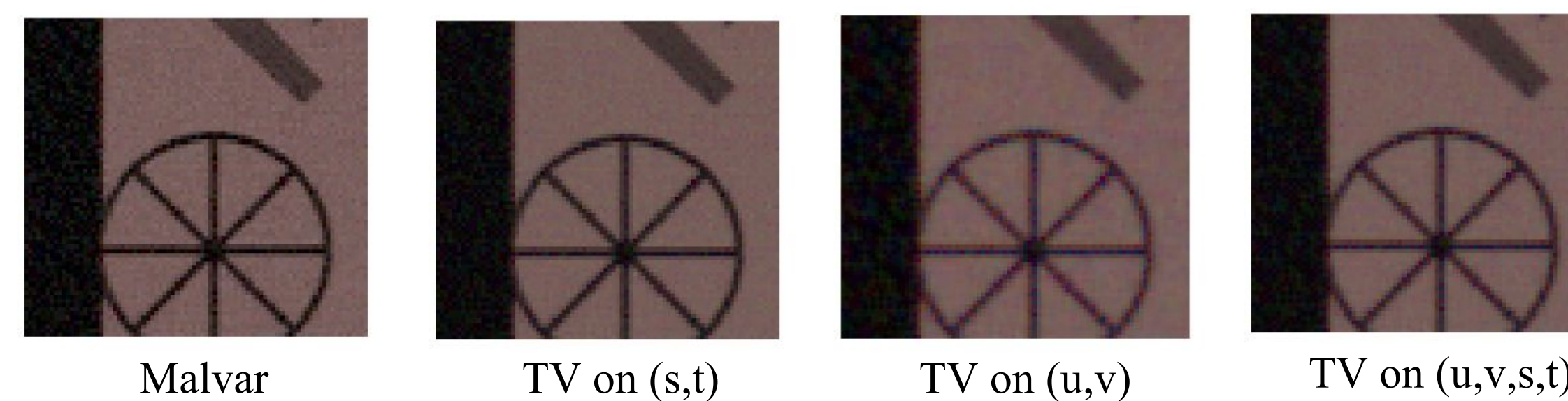


- Plot generated with simulated low-resolution (80x80 microlens) data



Full Color Image

Mean Illumination Level = 3 lux



Future Work

- Apply a cross-channel prior
- Design a color prior that works across the four dimensions

References:

- [1] Farrell, Joyce E., et al. "A simulation tool for evaluating digital camera image quality." *Electronic Imaging 2004*. International Society for Optics and Photonics, 2003.
- [2] Ng, Ren, et al. "Light field photography with a hand-held plenoptic camera." *Computer Science Technical Report CSTR 2.11* (2005).
- [3] Malvar, Henrique S., Li-wei He, and Ross Cutler. "High-quality linear interpolation for demosaicing of Bayer-patterned color images." *Acoustics, Speech, and Signal Processing, 2004. Proceedings. (ICASSP'04). IEEE International Conference on*. Vol. 3. IEEE, 2004.