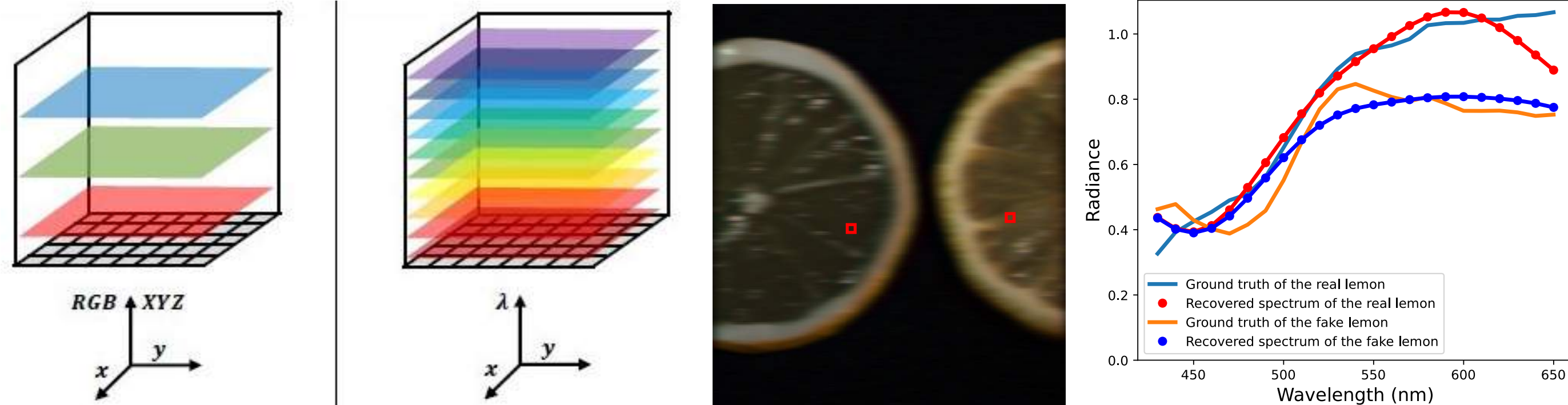# Reconstruct a Hyperspectral Image from a Single Shot

Yixuan Shao
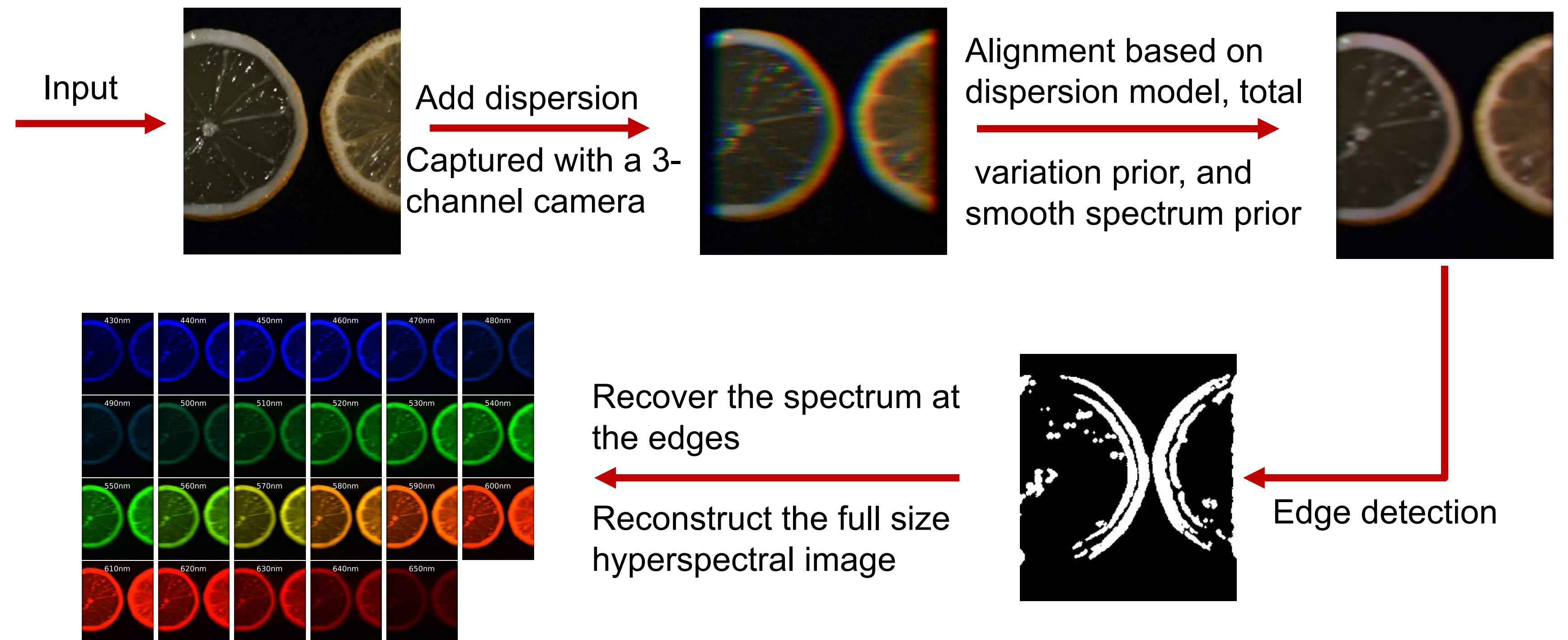
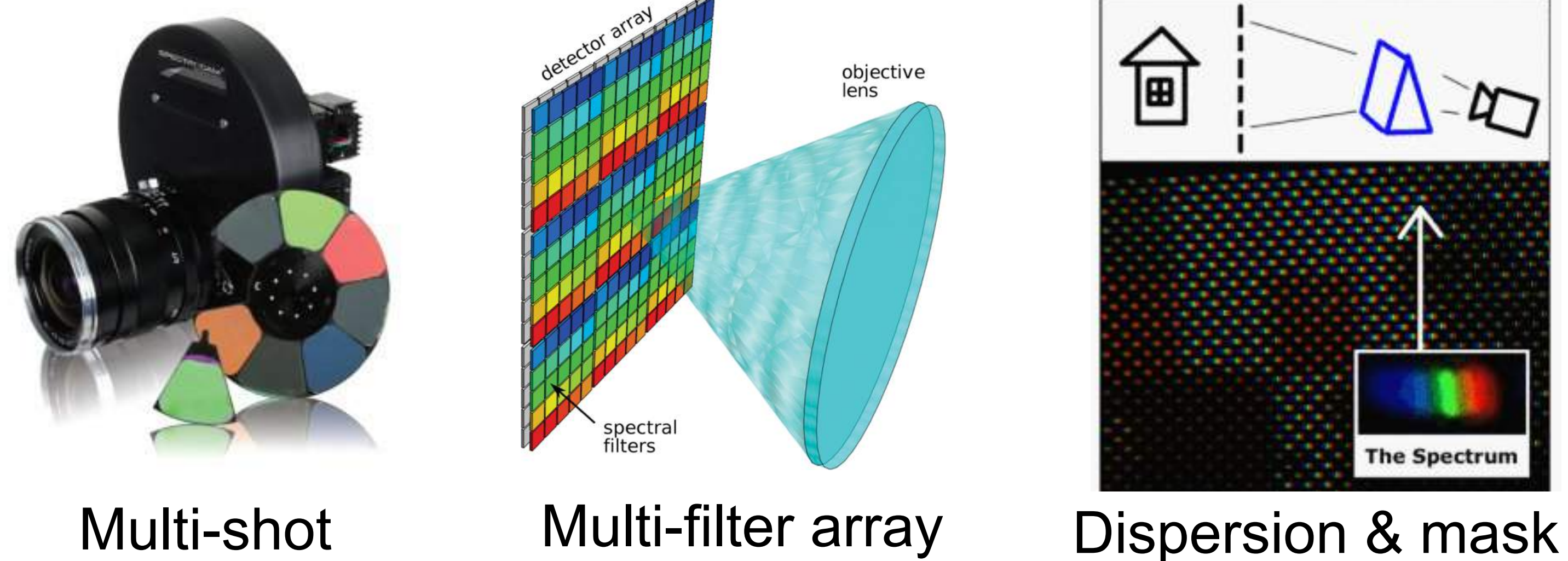Department of Electrical Engineering, Stanford University

Motivation

- More wavelength channels compared to RGB images
- Useful in many fields such as material discrimination
- Existing methods are usually expensive, require complicated optics and suffer from low spatial resolution or temporal resolution
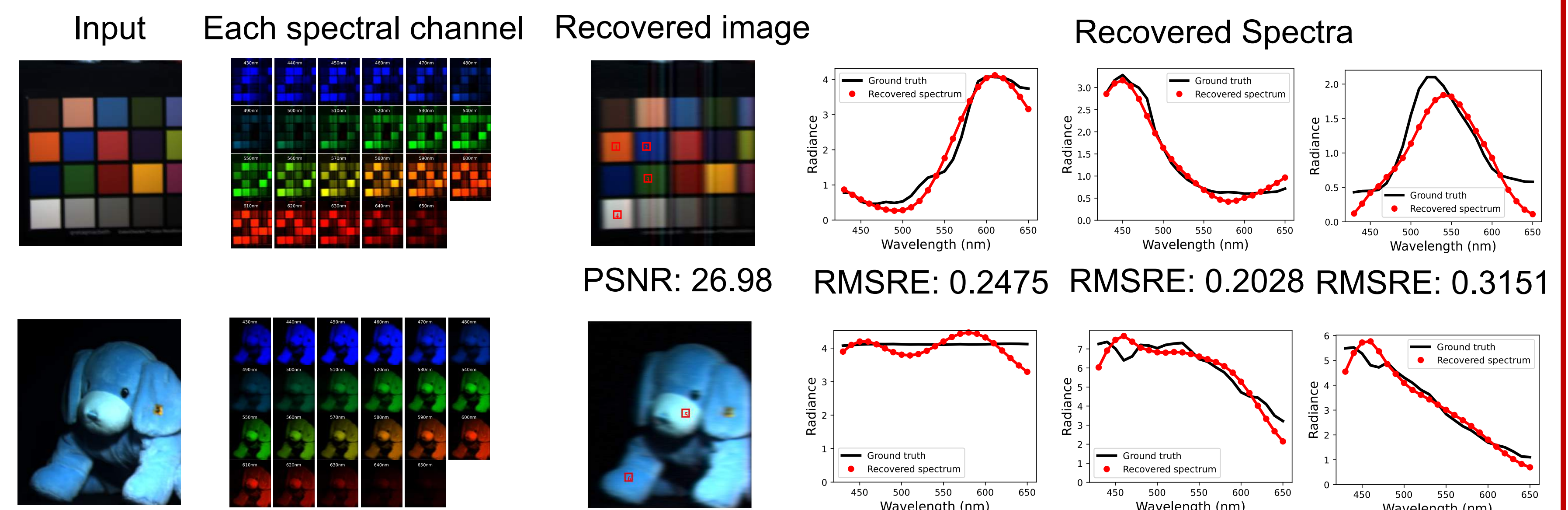

Related Work

Multi-shot   Multi-filter array   Dispersion & mask

References

[1] Hagen, N., et al. "Review of snapshot spectral imaging technologies," Optical Engineering, vol. 52, no. 9, p.090901, 2013.
[2] Cao, X., et al. "A prism-mask system for multispectral video acquisition," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 33, no. 12, pp. 2423–2435, 2011
[3] Baek, S. et al. "Compact single-shot hyperspectral imaging using a prism," ACM Trans. Graph., vol. 36, no. 6, nov 2017.

Method

Input → Add dispersion, Captured with a 3-channel camera → Alignment based on dispersion model, total variation prior, and smooth spectrum prior → Edge detection → Recover the spectrum at the edges → Reconstruct the full size hyperspectral image

Results

Input   Each spectral channel   Recovered image   Recovered Spectra

PSNR: 26.98   RMSRE: 0.2475   RMSRE: 0.2028   RMSRE: 0.3151

PSNR: 24.39   RMSRE: 0.0752   RMSRE: 0.1222   RMSRE: 0.1386

RMSRE: root mean squared relative error

$$\text{RMSRE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\frac{\bar{H}_d^{i,m} - \bar{H}_d^{i,c}}{\bar{H}_d^{i,m}}\right)^2}$$