# Spectral DefocusCam: compressive hyperspectral imaging from defocus measurements

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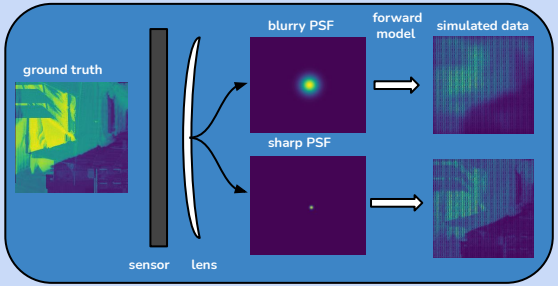
***Abstract:*** Hyperspectral imaging is useful for applications ranging from medical diagnostics to agricultural crop monitoring; however, traditional scanning hyperspectral imagers are prohibitively slow and expensive for widespread adoption (the cheapest hyperspectral cameras cost more than USD20,000, whereas cellphone cameras can cost ~USD10). Snapshot hyperspectral cameras aim to capture a hyperspectral volume in a single encoded image. In this project, we aim to design a new hyperspectral camera that is compact and inexpensive, but able to capture high resolution hyperspectral volumes. ***We propose using a tunable lens that can rapidly change its focus paired with a 31-channel spectral filter array mounted on a CMOS camera.*** By rapidly taking a burst of several images with different amounts of defocus, we aim to encode both high resolution spatial and spectral information.

***In this poster, we simulate this camera and evaluate a reconstruction algorithm for it.***

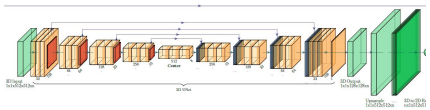
## Dataset

- Harvard's Real-World Hyperspectral Images Database
- 77 indoor and outdoor hyperspectral images
- 31 color channels
- Augmented with cropping, rotation → **5,000 training images**

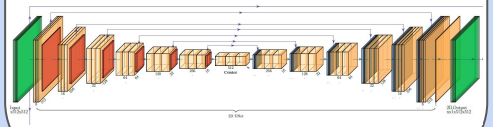
## Forward Model & PSFs



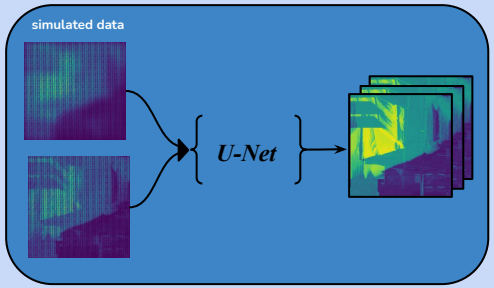

## 3D U-Net Architecture



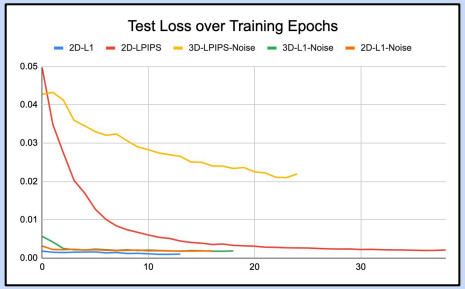
## 2D U-Net Architecture



## Reconstruction Algorithm

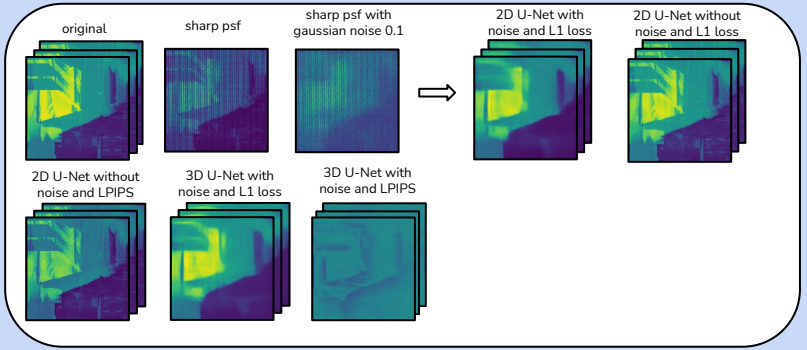



## Results & Performance




***Best with Noise:***
3D Unet with L1 Loss
Final Test Loss: ***0.0017832***

***Best without Noise:***
2D U-Net with L1 Loss
Final Test Loss: ***0.0009883***




## References:

Ayan Chakrabarti and Todd Zickler, "Statistics of Real-World Hyperspectral Images," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2011.

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