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MULTISPECTRAL FOCAL STACK ACQUISITION USING A CHROMATIC ABERRATION ENLARGED CAMERA

ICIP 2017

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Xiaoming Zhong, Jinli Suo,
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Demand

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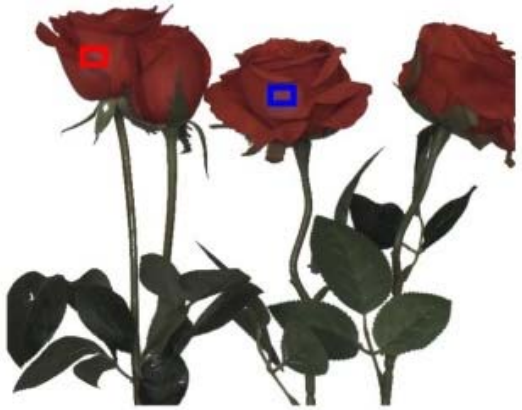
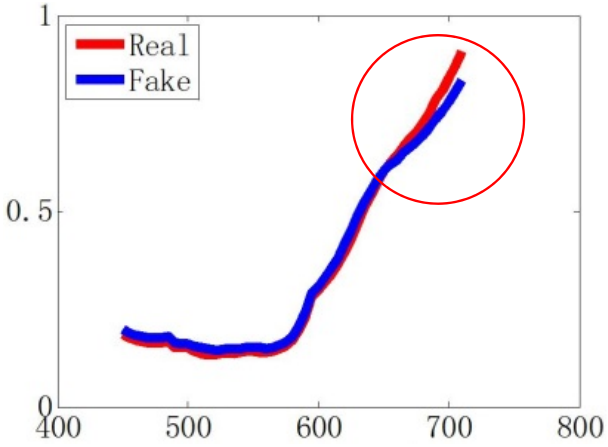
- **Growing desire of multispectral capture**
- Light field information





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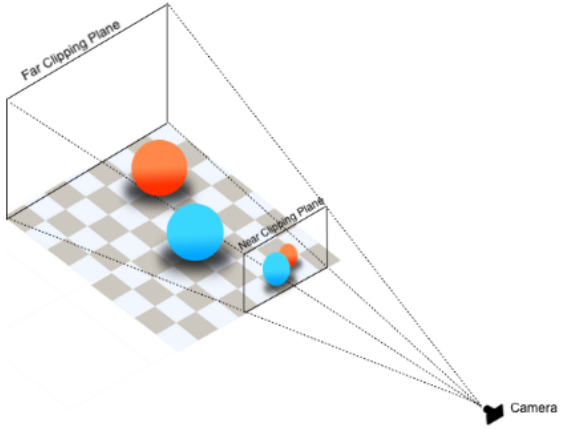

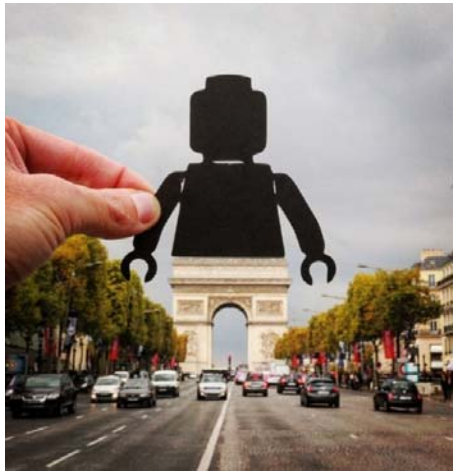

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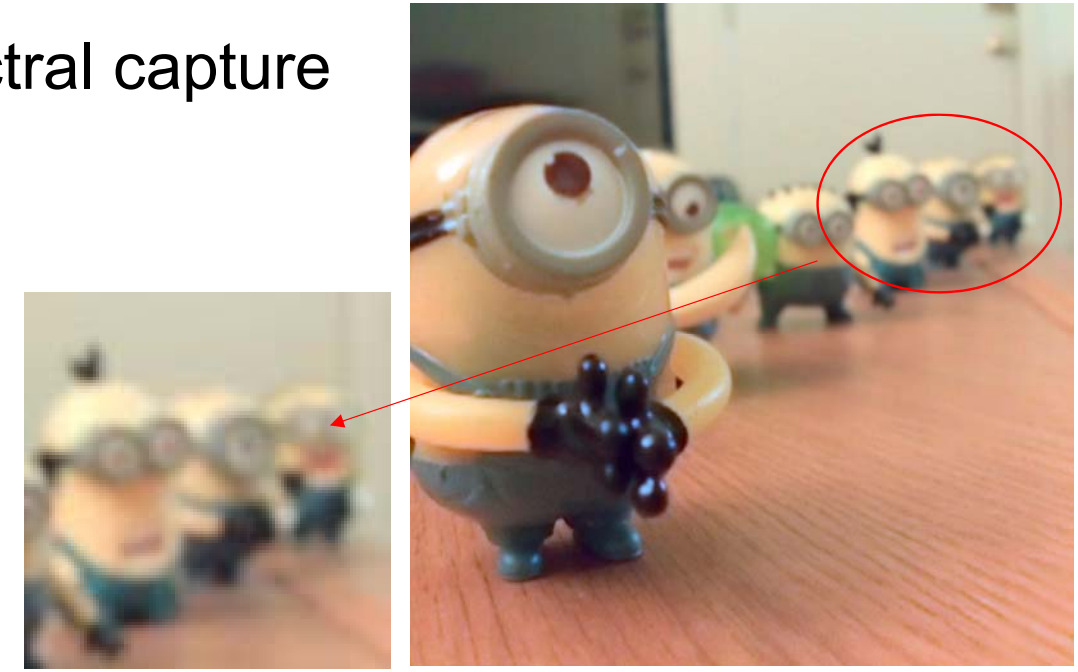

Related works

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- Multispectral camera
  - X Cao et al. PAMI(2011)
  - G R Arce et al. SPM(2014)
  - C Vandervlugt et al. ATMHU (2007)
- Light field imaging
  - Ren Ng et al. CSTR(2005)
  - C Zhang et al. ACM SIGGRAPH(2014)
  - N Li et al. CVPR(2014)
- Multispectral light field imaging
  - M Diebold et al. CVPR(2016)
  - Y Zhao et al. Optics Express(2017)

Use CA as a bridge

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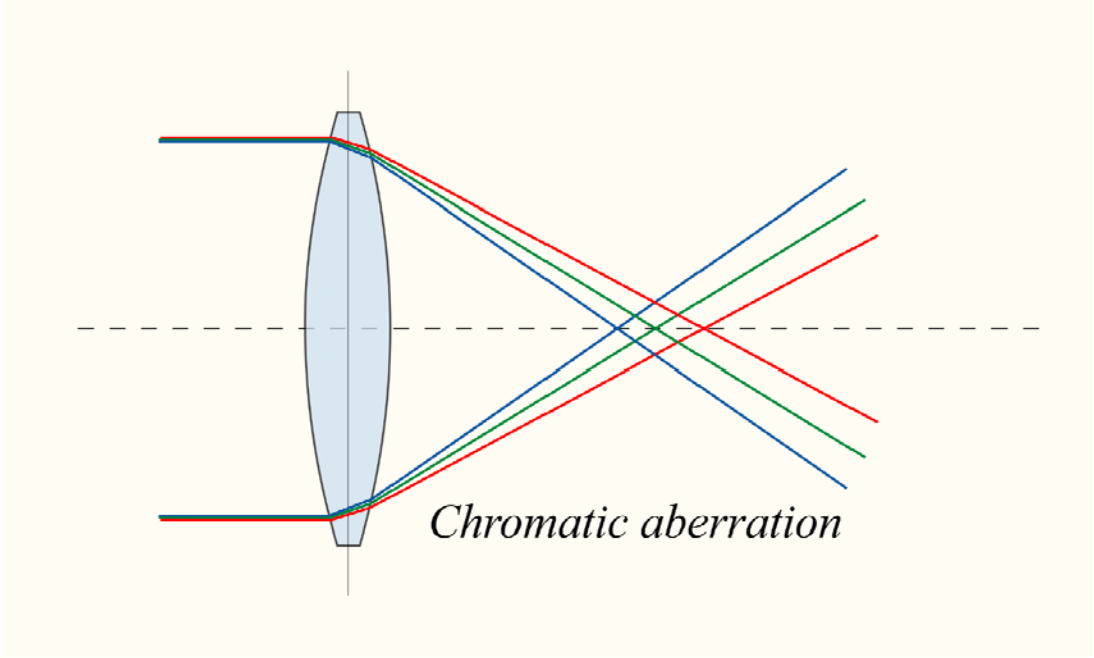

Use CA as a bridge

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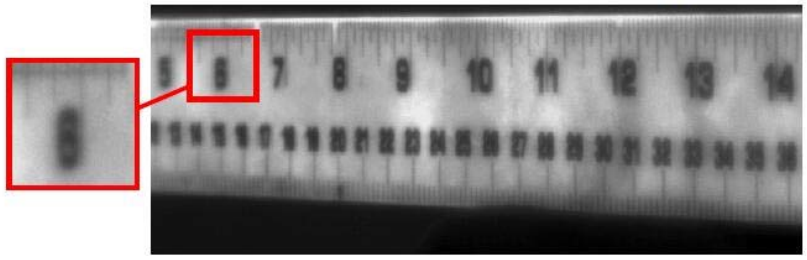
Related works:

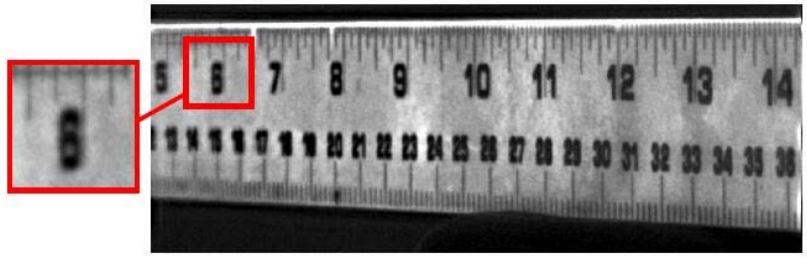
- O Cossairt et al. ICCP(2010)
- Trouve et al.

  APPLIED OPTICS(2013)

(a) An image captured with a corrected lens (8ms exposure)



(b) An image captured with a SFS camera (8ms exposure)



(c) The image from Figure 1(b) after deblurring

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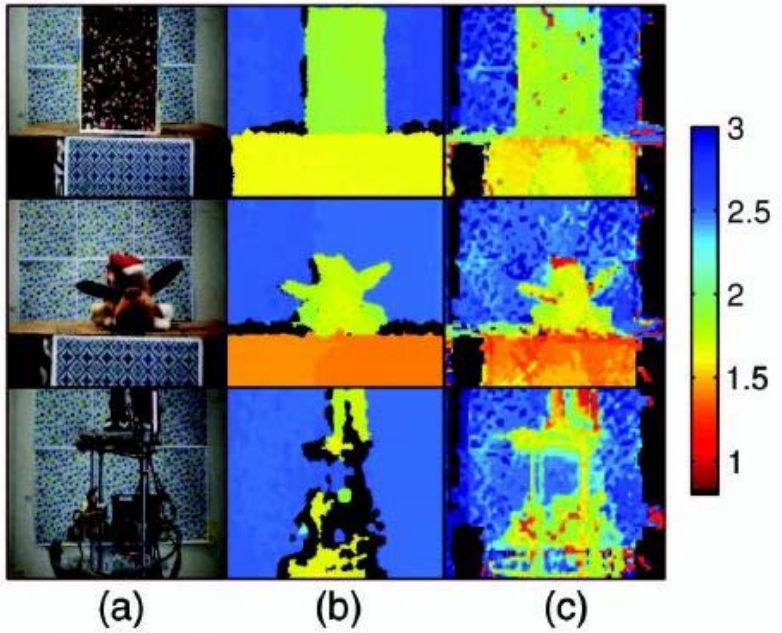

Fig. 14. Results of the prototype chromatic camera on indoor scenes. (a) Raw image acquired with the chromatic lens. (b) Kinect's depth map. (c) Raw depth map with CC-DFD with a patch size of 21×21 and 50% overlapping. The depth labels are in m. Black label corresponds to homogeneous regions rejected by the algorithm.

Desire

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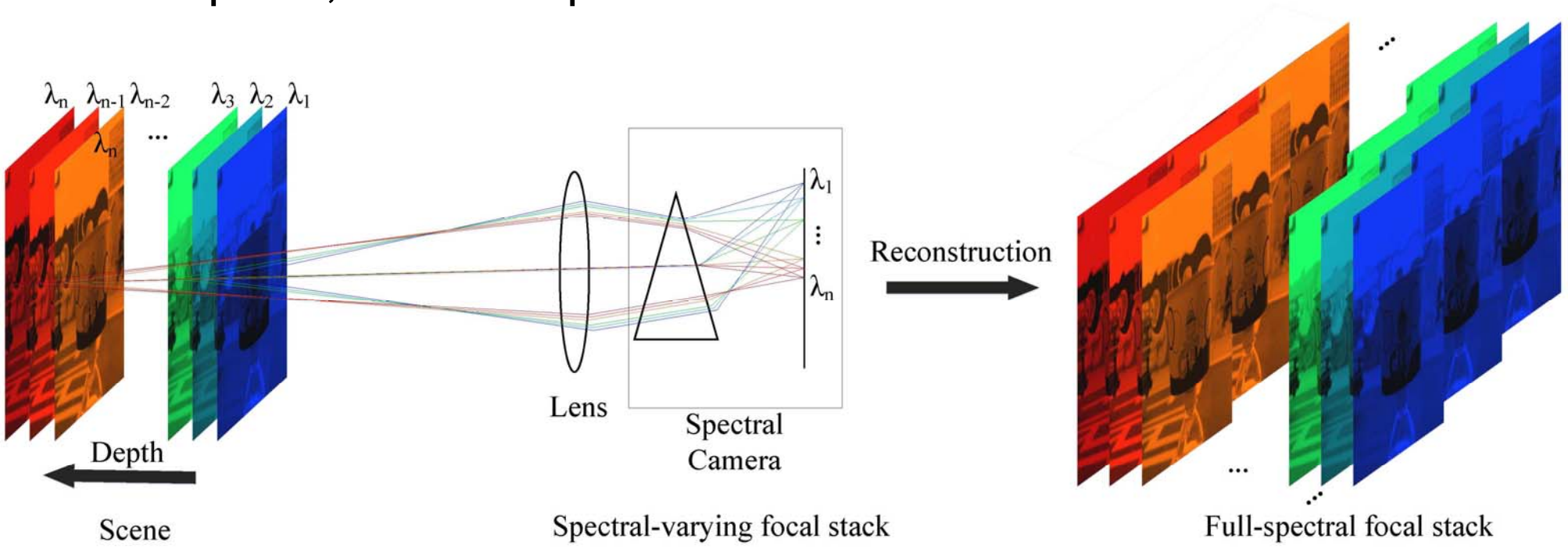
- One capture, full multispectral focal stack



Overview

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- Capture spectral-varying focal stack with special-designed camera
  - Enlarge chromatic aberration while eliminating rest aberration
- Reconstruct multispectral focal stack
  - Propose an Local linear Transformation(LLT) based algorithm to fill up the vacant channels of each slice.
- Byproduct: depth map

Optical System Design

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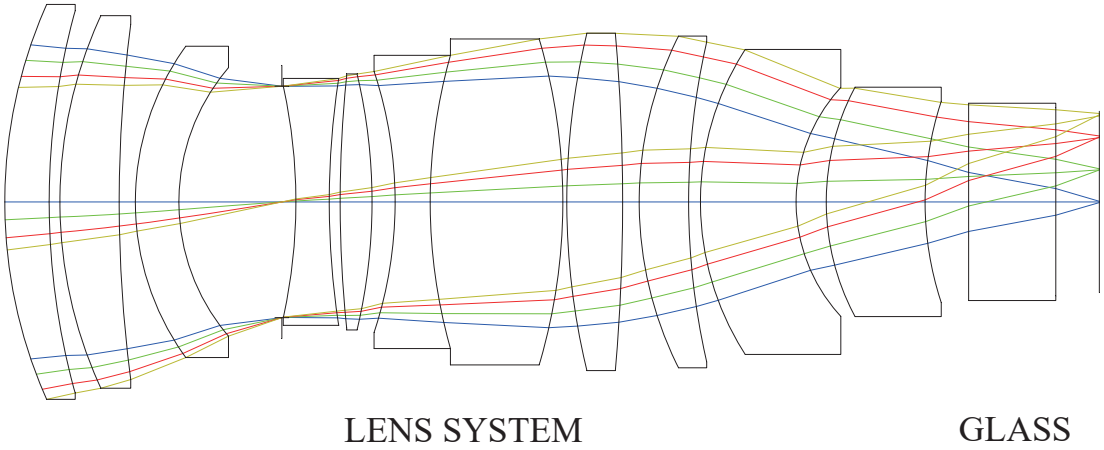
- Lens array

  Large CA

  Tiny rest aberrations



- Different focal planes at different depths in the scene

Multispectral Focal Stack Reconstruction

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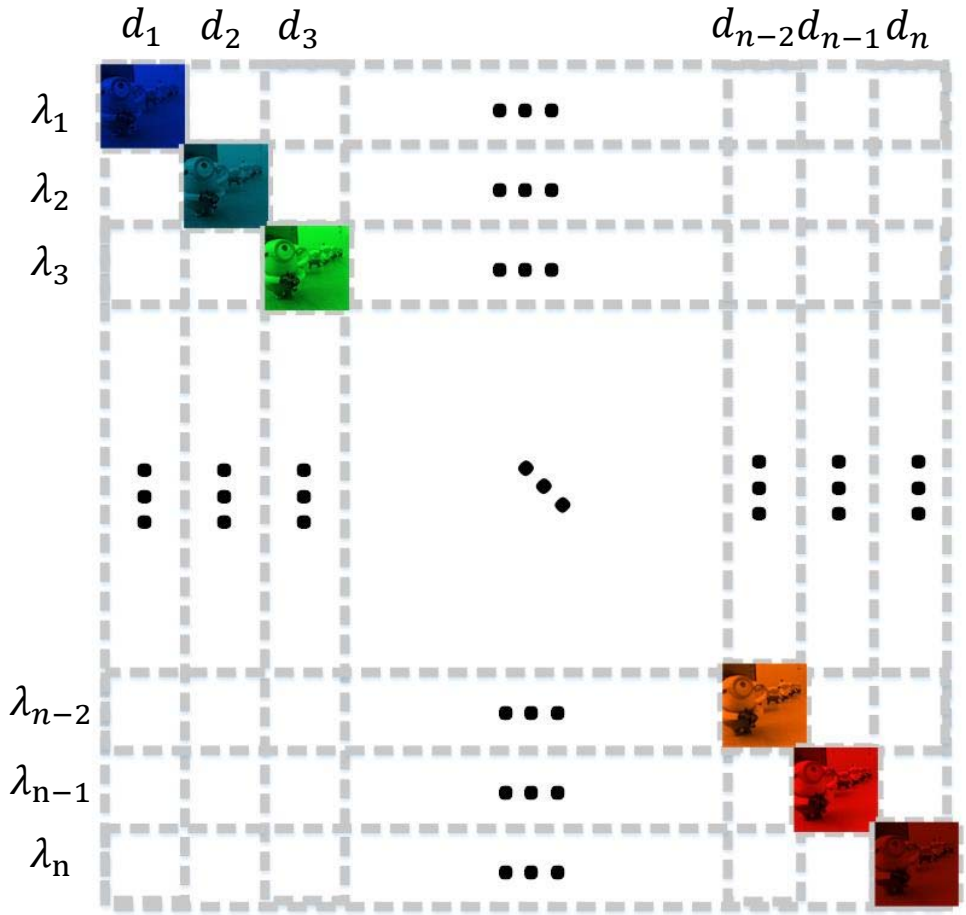

Multispectral Focal Stack Reconstruction

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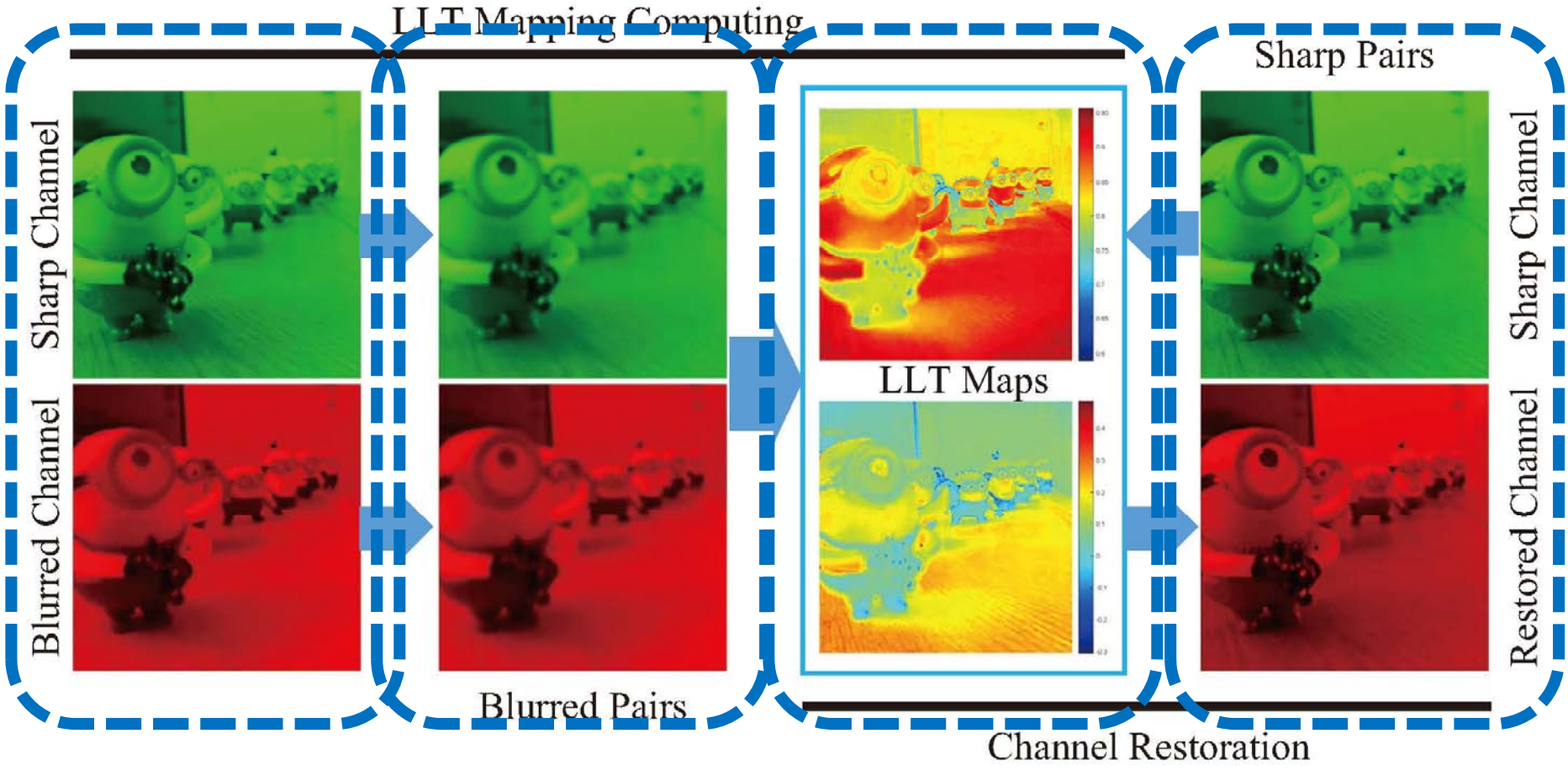

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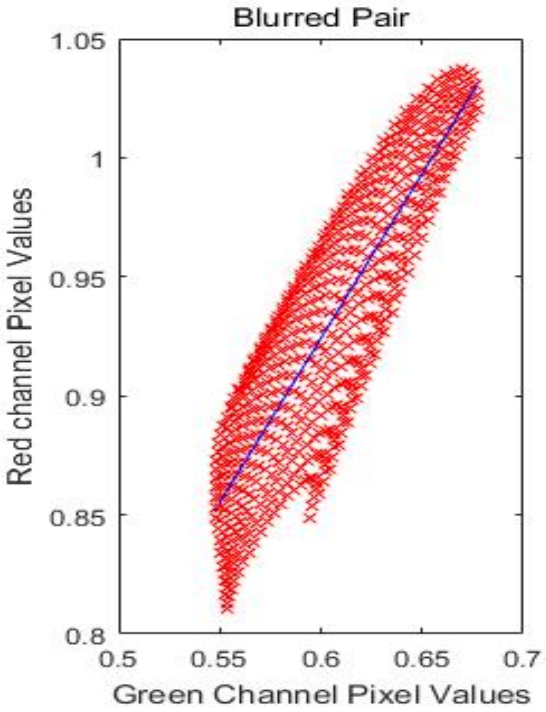
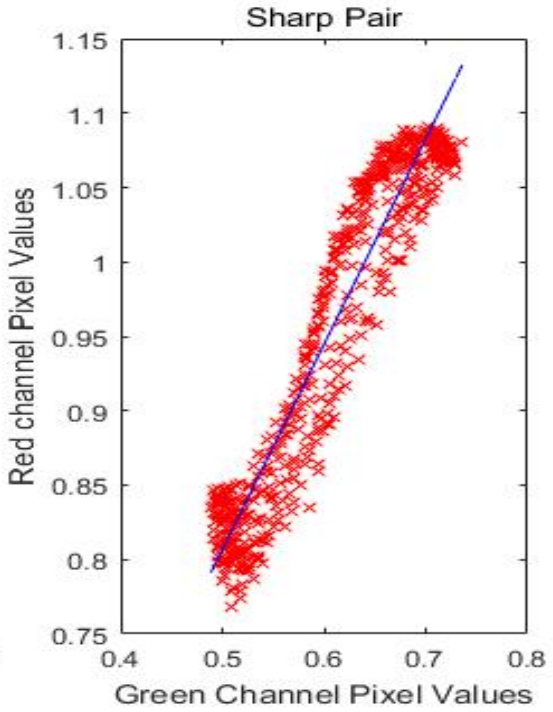
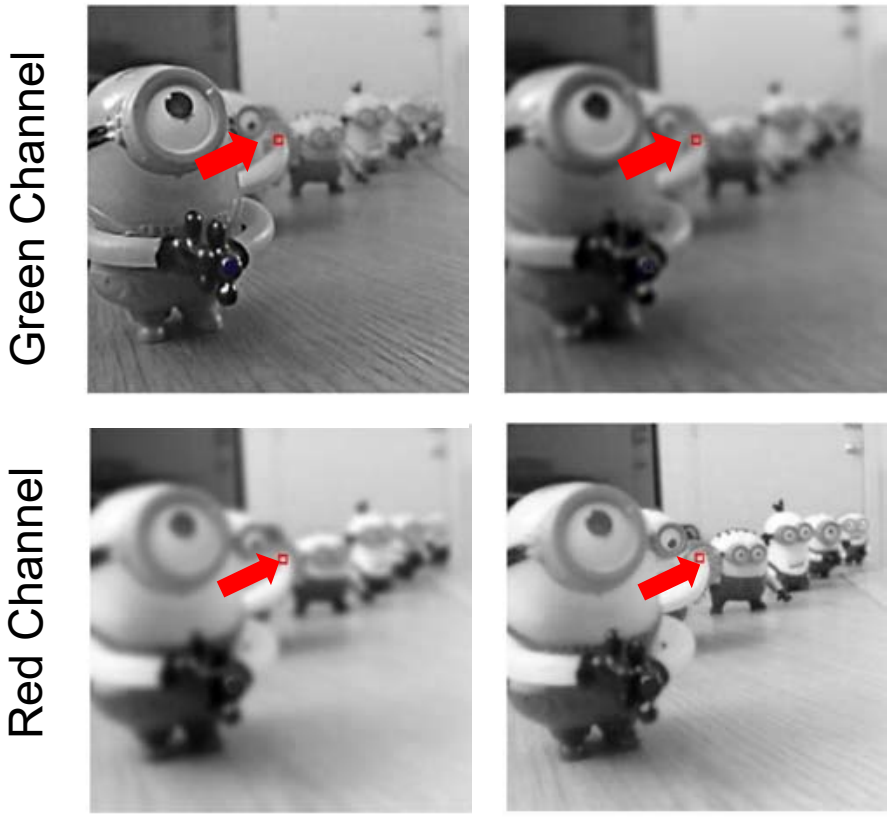
Local Linear Transformation



$$y = 1.3797x + 0.0963$$



$$y = 1.3808x + 0.1161$$



Shape Pair

Blurred Pair

Local Linear Transformation

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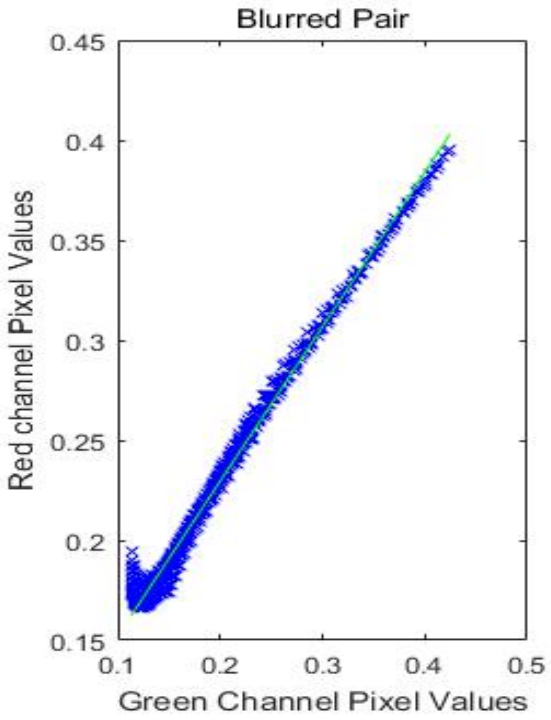
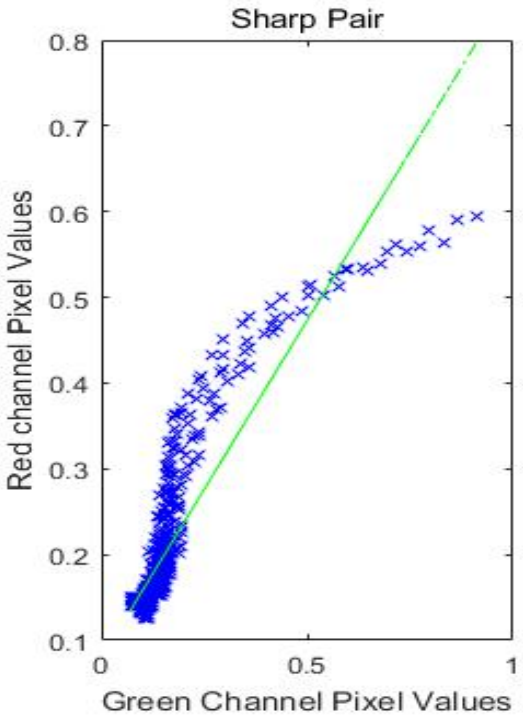
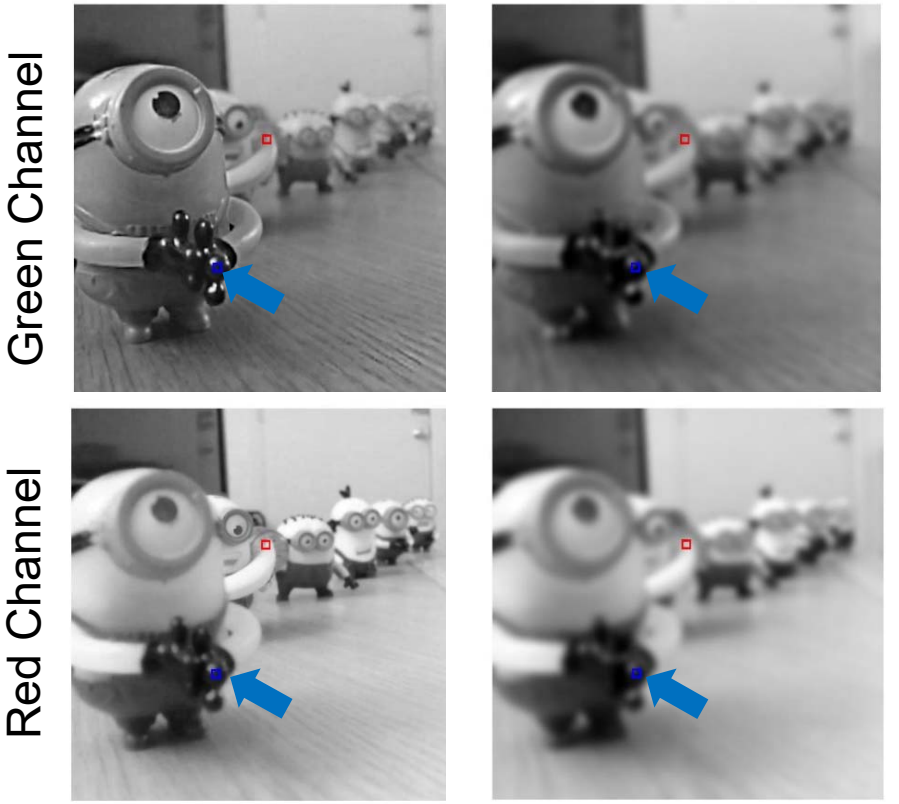




$y = 0.7724x + 0.0750$

$y = 0.7876x + 0.0793$



Shape Pair

Blurred Pair

Experimental Result

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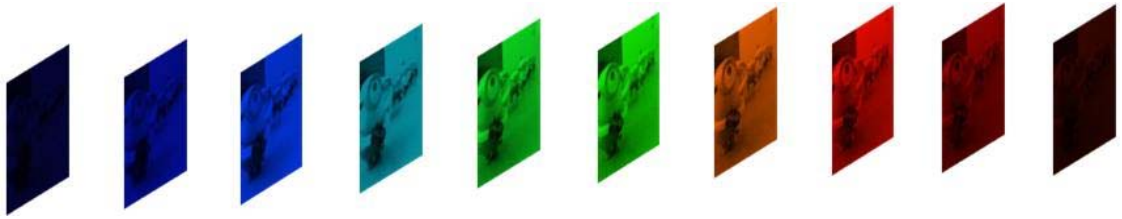
Input



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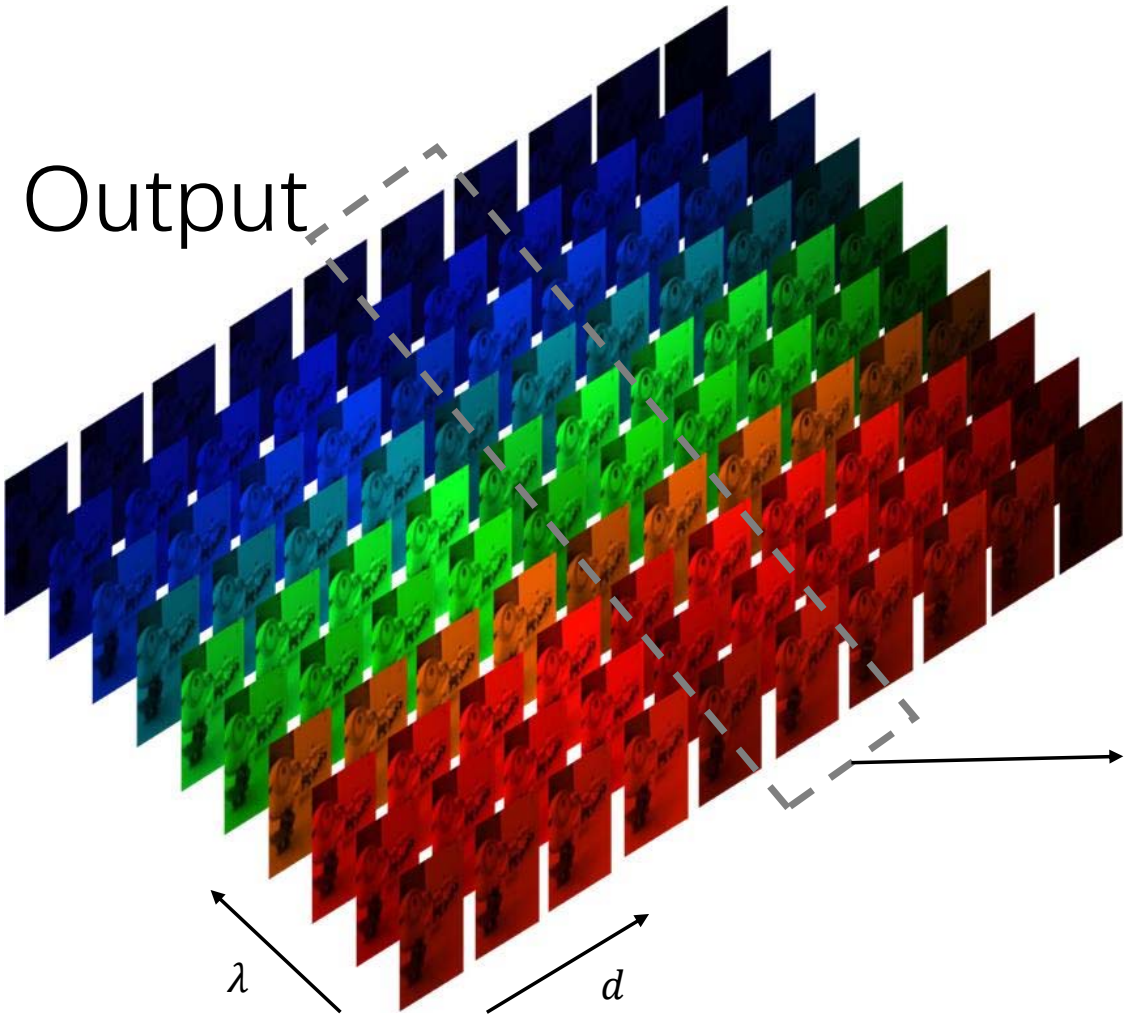
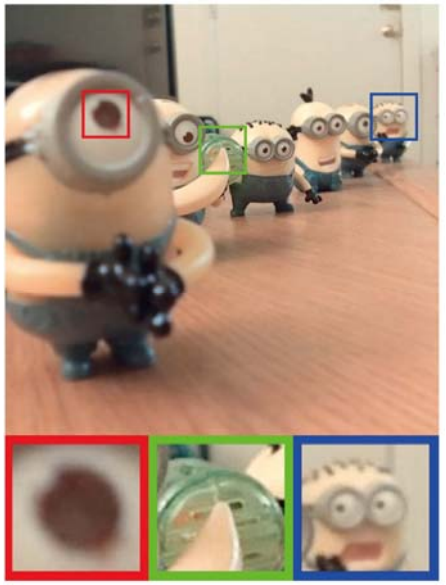
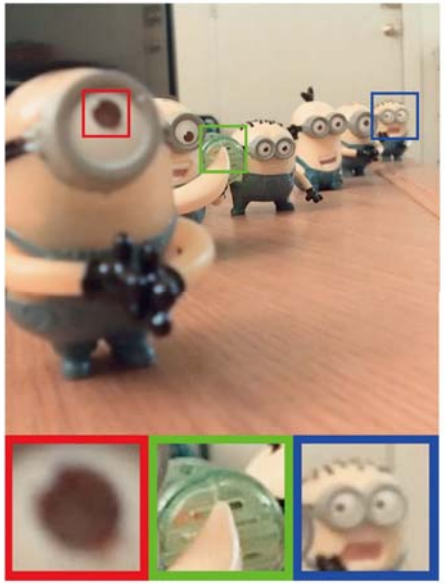




Synthesized RGB



Ground Truth

Experimental Result

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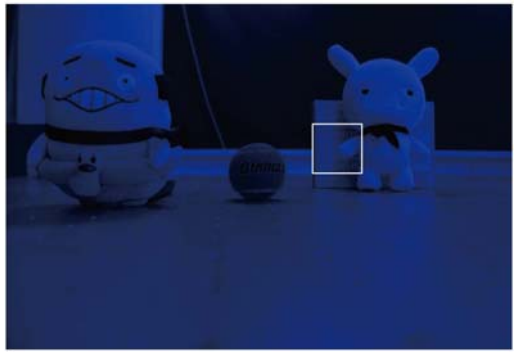
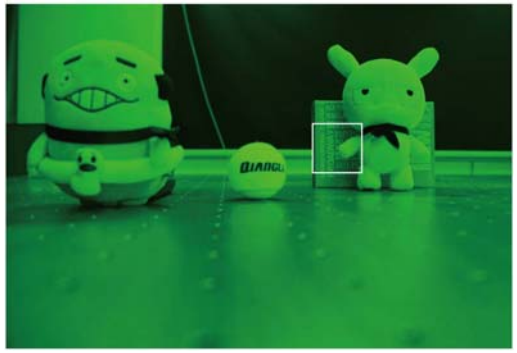
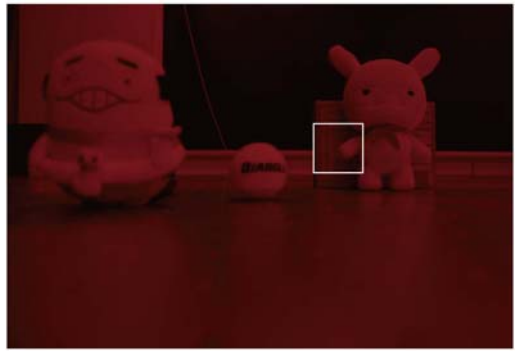
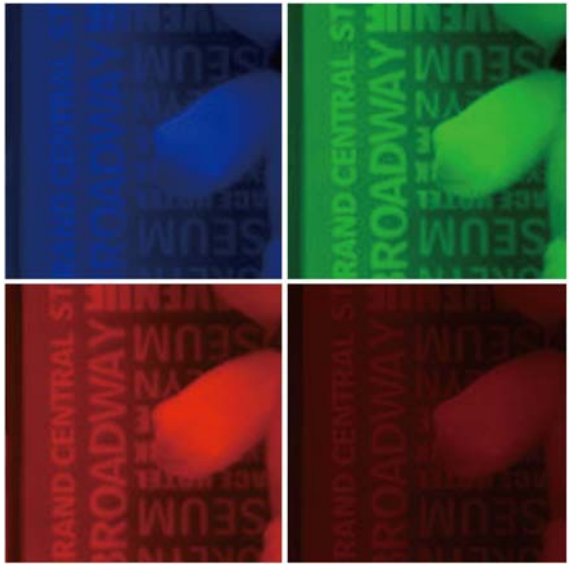






Details



Quantitative Evaluation

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	λ=430nm		λ=520nm		λ=610nm		λ=700nm	
	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
Depth1	Inf	1	34	0.9799	35.08	0.9811	35.70	0.9841
Depth4	39.79	0.9768	Inf	1	37.76	0.9829	35.26	0.9729
Depth7	42.27	0.9867	36.28	0.9808	Inf	1	42.26	0.9959
Depth10	38.20	0.9801	30.44	0.9684	33.55	0.9859	Inf	1

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Conclusion

- chromatic aberration enlarged camera system
- LLT-based multispectral focal stack reconstruction
- Great quantitative and qualitative performance

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Thanks!