MULTISPECTRAL FOCAL STACK ACQUISITION USING A CHROMATIC ABERRATION ENLARGED CAMERA

ICIP 2017

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Demand

• Growing desire of multispectral capture

• Light field information
Demand

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• Light field information
Related works

• 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

CITE

Chromatic aberration
Use CA as a bridge

Related works:
• O Cossairt et al. ICCP(2010)
• Trouve et al. APPLIED OPTICS(2013)
Use CA as a bridge

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• Trouve et al. APPLIED OPTICS(2013)

![Image of camera and depth maps](image)

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 x 21 and 50% overlapping. The depth labels are in m. Black label corresponds to homogeneous regions rejected by the algorithm.
Desire

- One capture, full multispectral focal stack
Overview

• 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

• Lens array
  Large CA
  Tiny rest aberrations

• Different focal planes at different depths in the scene
Multispectral Focal Stack Reconstruction
Multispectral Focal Stack Reconstruction

LLT Mapping Computing

Sharp Pairs

Blurred Channel

Sharp Channel

Blurred Pairs

LLT Maps

Restored Channel

Channel Restoration
Local Linear Transformation

\[ y = 1.3797x + 0.0963 \]

\[ y = 1.3808x + 0.1161 \]
Local Linear Transformation

\[ y = 0.7724x + 0.0750 \]

\[ y = 0.7876x + 0.0793 \]
Experimental Result
Input
CITE

Output

\[ \lambda \]

\[ d \]

Synthesized RGB

Ground Truth
Experimental Result
## Quantitative Evaluation

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<th>Depth</th>
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<th>$\lambda=520nm$</th>
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Conclusion

• chromatic aberration enlarged camera system

• LLT-based multispectral focal stack reconstruction

• Great quantitative and qualitative performance
Thanks!