Coded Exposure HDR Light-Field Video Recording

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Exposure Sequence

long exposed
short
HDR Image
HDR Image

| static | motion |

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HDR Light Field

- Exposure sequence
  - each perspective

- Reduce motion blur
Multiplexing Colors

- Bayer pattern
  - multiplexing colors
- Pixel quad-tuple
  - green 2x
- Interpolation
  - color (demosaicing)
Multiplexing Exposure Times

• Our approach
  – multiplex exposures (4)

• Camera quad-tuple
  – interleave exposures (2x)

• Interpolate
  – perspectives
Multiplexing Exposure Times

quad-tuple
Multiplexing Exposure Times

• Reduced capturing time

strong motion blur

motion blur

motion blur

quad-tuple
Multiplexing Exposure Times

- Reduced capturing time

![Diagram showing deblurring at different exposure times with quad-tuple presentation]
Related Work: LF Cameras

• [Wilburn et al. 2005]
  – mosaicing for single images

• [Georgiev et al. 2009, Georgiev et al. 2010]
  – aperture varies / ND filter
Related Work: Deblurring

• [Tai et al. 2008]
  – 2nd high fps camera

• [Xu and Jia, 2012]
  – deblur stereo-pair
Our Approach

capture -> registration -> PSFs -> segmentation

capture

depth

depths

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Our Approach

capture

registration

PSFs

depth

depths

segmentation
Our Approach (cont)

segmentation → deblur → deblurred → interp. → full HDR light field
Outline

capture
 registration
 PSFs

depth
 depths
 segmentation

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Capturing

regular exposure sequence

encoded exposure (interleaved)

1 subframe
1+2 subframes
2+1 subframes
8 subframes

quad-tuple
Capturing 1 Frame

1 subframe

2+1 subframes

1+2 subframes

8 subframes
Outline

- Capture
- Depth
- Depths
- Registration
- PSFs
- Segmentation
Registration

- SURF
  - 3D features
  - matches subf.
- Registration
  - rotation & translation
Registration (cont.)

• For every exposure (except longest)
  – use previous as initial guess
Registration (cont.)

• up sample (to 7x)
PSF Calculation

- 3D features: best registration per projection
- Cluster: PSF depths
Composite Depth Map

• Compute depth for each exposure time
Composite Depth Map

- Compute depth for each exposure time
- Composite depth map: based on confidence
Our Approach

capture

registration

PSFs

depth

depths

segmentation
Scene Segmentation

- PSF depth clusters
- Dense PSF map: inter- & extrapolate
- Raw clusters: cluster PSF map

composite depth map ➔ PSF map ➔ raw clusters (k=2)
Scene Segmentation

- PSF depth clusters
- Dense PSF map: inter- & extrapolate
- Raw clusters: cluster PSF map
Scene Segmentation (cont.)

- Refine raw clusters [Levin, 2006]
Our Approach

segmentation → deblur → deblurred → interp. → full HDR light field
Deblur Clusters

• Deblur PSF: least upsampled
• Non-blind deconvolution
Deblur Clusters

• Deblur PSF: least upsampled
• Non-blind deconvolution
Deblur Clusters

- Deblur PSF: least upsampled
- Semi-Blind Deconvolution

Cluster 1

deblur

non-blind

deblur [Levin, 2011]

blind (+initial guess)
Merge Clusters

• Blend deblurred clusters
Merge Clusters

• Blend deblurred clusters
Exp. sequence
– 1 frame: 15

Coded Exp.
– 2 frames: 8

3.75x fps
Our Approach

segmentation → deblur → deblurred → interp. → full HDR light field

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Deblurred Composite Depth Map

• Recompute depth from deblurred perspectives
Deblurred Composite Depth Map

• Recompute depth from deblurred perspectives
Interpolation

- Interpolate missing perspectives
- Exposure sequence at each perspective
Example 2: Camera Rotation

HDR: exposure sequence

HDR: coded exposure
Thanks!

Our Poster
Level 3 Ballroom Foyer
Tue & Wed: 12:15 to 1:15pm

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