Prior work on analysis of CI systems

Related performance to practical considerations such as lighting levels and sensor characteristics

Large gain at low light levels

Limitation: Did not take signal priors into account

State-of-the-art algorithms use signal priors

Denoising using BM3D
Dabov et al. [2006], Lumsdaine et al. [2010]

Inpainting using GMM
 Yang et al. [2007], Yu et al. [2011]

Coded exposure video using dictionary learning
 Yang et al. [2008], Dabov et al. [2011]

How does CI improve performance?

1. Increased light throughput
2. Well conditioned optical coding

Short exposure
Large exposure
Flutter Shutter

Our analysis takes into account:
- Signal prior
- Multiplexing matrix
- Noise characteristics

Complete specification of the analysis framework

Complete specification of the analysis framework

We model signal prior using Gaussian Mixture Model (GMM)

1. Universal approximation property
2. Analytically tractable
3. State-of-the-art results

Our model signal prior using Gaussian Mixture Model (GMM)

We use the Minimum Mean Square Error (MMSE) as a metric to evaluate performance

Practical system performance depends on

1. Illumination level \( (l_i) \)
2. Scene reflectivity \( (R) \)
3. Camera parameters

Average signal level is given by:

\[
I = 10^{\frac{1}{20}M} \cdot R \cdot (\frac{S}{2})^{2} \cdot t_{exp}^{2}
\]

Single pixel camera
Light field cameras
Programmable micropixel camera

Analysis of Extended Depth of Field (EDOF) systems

Systems compared:
1. Impulse system
2. Final image (FI)
3. Coded aperture
4. Coded aperture
5. Coded aperture

Analysis of Motion Deblurring systems

Systems compared:
1. Impulse system
2. Flutter shutter (FS)
3. Motion/cameraphotography (Cho et al. 2010)

Analysis of Light Field systems

Systems compared:
1. Impulse camera
2. MURA
3. MURA

Conclusions

1. More gain due to prior than due to multiplexing
2. EDOF systems provide 9 dB gain over impulse imaging
3. Motion deblurring systems provide 7.5 dB gain over impulse imaging
4. Light field systems provide 12 dB gain over impulse imaging