Reconstruction of compressive light field data

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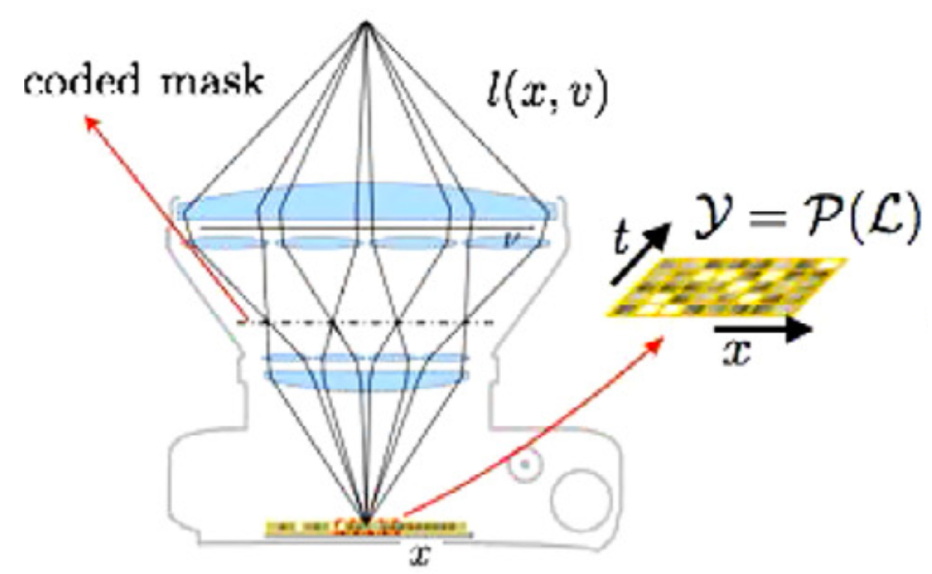
Introduction & Motivation

- Light field photography records both spatial and angular (4D) information, allowing for new applications
  - Depth estimation, Occlusion removal, etc.
- However, intrinsic tradeoff between spatial and angular resolution
- Different physical design: combining different views (angular) while adding 5th dimension (time frame) [1]
  - Spatial resolution reserved
  - Needs to be reconstructed
- Compressive sensing for image reconstruction

$$\underset{\{x\}}{\text{minimize}}\ \frac{1}{2}\|b-Ax\|_2^2+\lambda\Gamma(x)$$



Related Work

- Super resolution algorithm: linear optimization, not work for compressive light field data [2]
- 4D light field dictionary: learning phase computationally slow and expensive [3]
- Compressive light field photography reconstruction using low rank and sparse priors [1]
- Different priors/constraints including: total variation, locally/globally low-rank [4], L1-DCT.

References

[1] Kamal et al., Computer Vision and Image Understanding, 2016
[2] Bishop et al., Proceedings of the ICCP, IEEE, 2009
[3] Marwah et al., ACM Trans. Graph,2013
[4] Jain et al., ACM symposium on Theory of computing. ACM, 2013.

New Technique

Our low-rank + sparse formulation:

$$\min_{L,S}\|A(L+S)-b\|_2^2+\lambda_1P_1(L)+\lambda_2P_2(S)$$

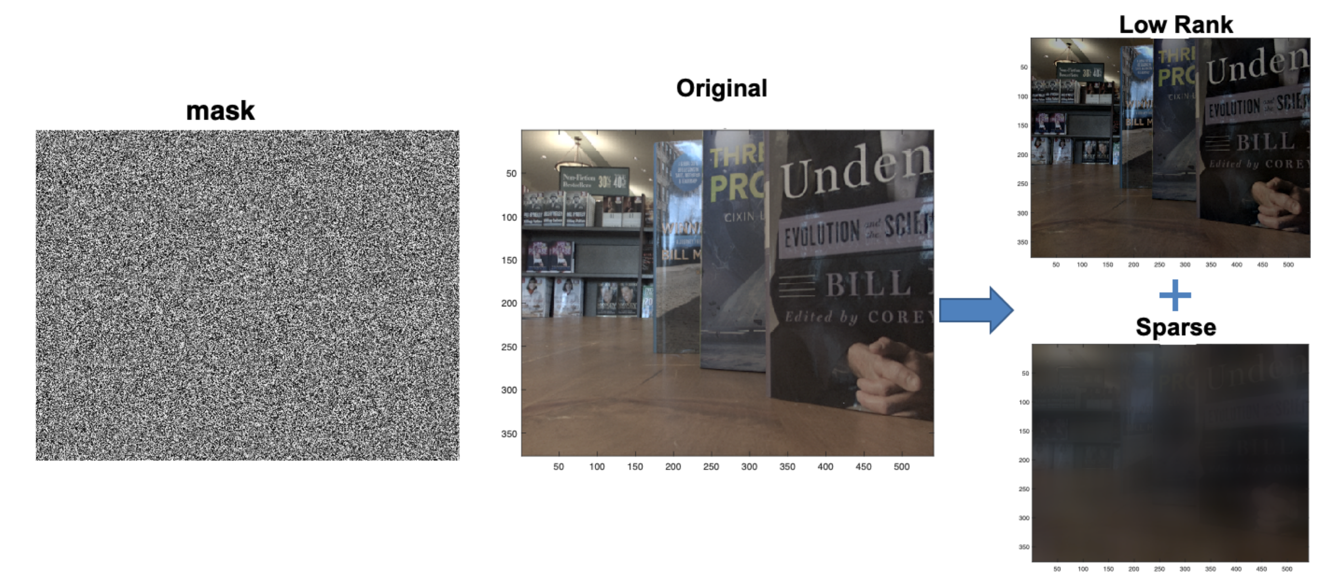
Update rule using **ADMM**

while stop criterion false **do**

$$L^{k+1}=argmin_L\ \|A(L+S^k)-b\|_2^2+\rho/2\,\|L-Z_1^k+U_1^k\|_2^2$$
$$S^{k+1}=argmin_S\ \|A(L^k+S)-b\|_2^2+\rho/2\,\|\Psi(S)-Z_2^k+U_2^k\|_2^2$$
$$Z1=prox_{\frac{\lambda_1}{\rho}P_1}(L^{K+1}+U_1^{k+1})$$
$$Z2=prox_{\frac{\lambda_2}{\rho}P_2}(\Psi(S^{K+1})+U_2^{k+1})$$
$$U_1^{k+1}=U_1^k+L^{k+1}-Z_1^{k+1}$$
$$U_2^{k+1}=U_2^k+\Psi(S^{k+1})-Z_1^{k+1}$$

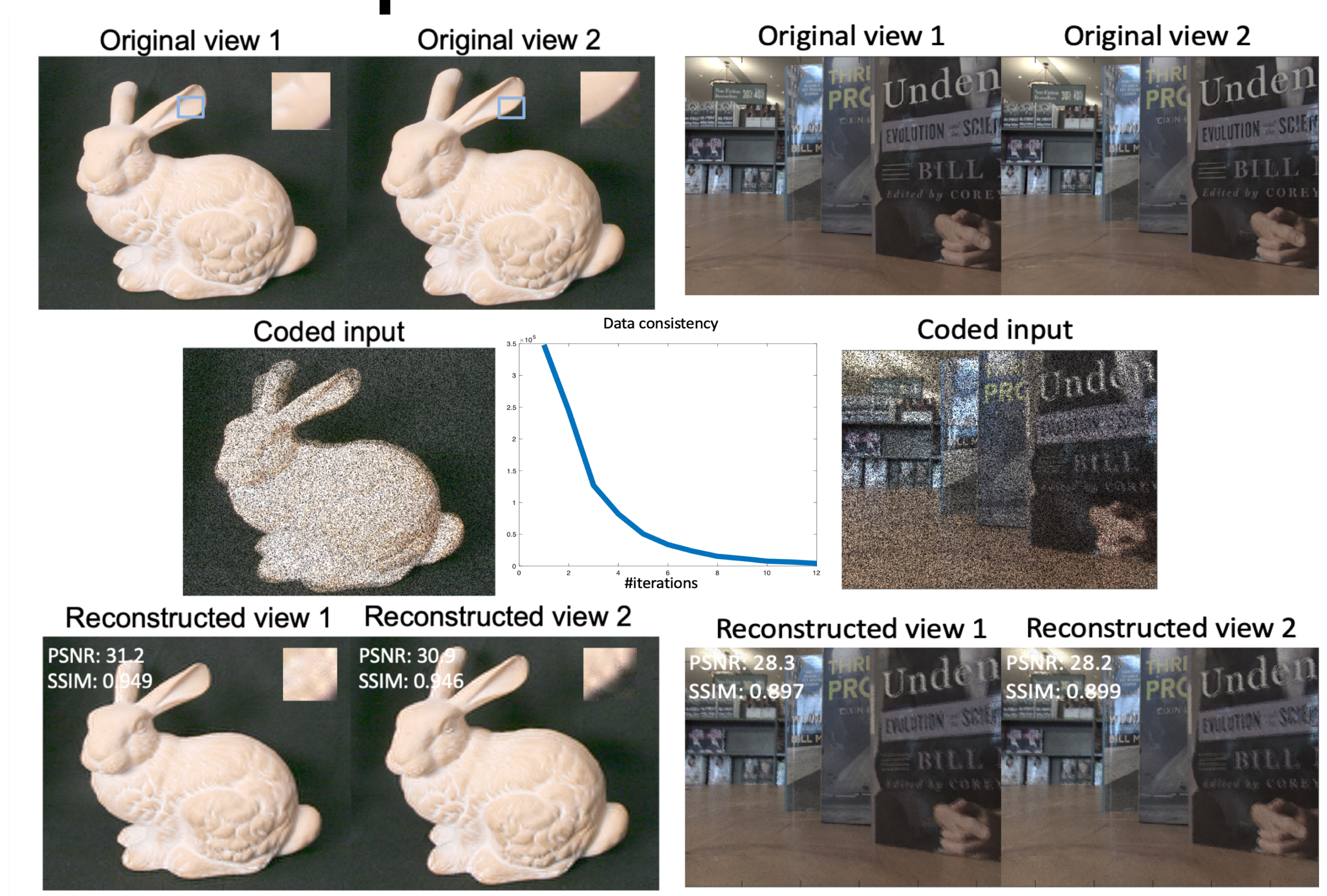
return L, S

	Explanations
A	mask operator at all V views and all T frames
L/S	low rank/sparse component (V views in total)
b	acquired view-combined image (T frames in total)
λ_1, λ_2	regularization parameters
P_1	prior on low rank term (locally low-rank, globally low-rank)
P_2, Ψ	prior on sparse term (l1-wavelet, l1-fft, l1-dct, l2, TV)



*Code available at https://drive.google.com/open?id=1XDZsROvJaLwXzfpkCJR6GRPxOVA9FVYf

Experimental Results



*Data from http://graphics.stanford.edu/data/LF/lfs.html

Summary

- Able to recover multiple views from compressive light field data.
- Formulated the recovery as a two-component model (low rank + sparse) and implemented corresponding ADMM algorithm to solve it.
- Still exploring different models, different combinations of priors and parameter space.