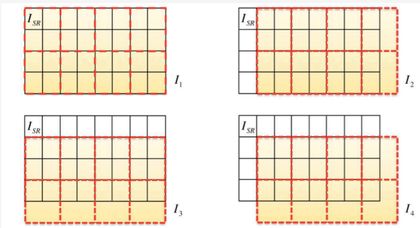
Super-Resolution Reconstruction Without Explicit Motion Estimation

Stanford University

Xilei Wang, Xiao Ju
Department of Electrical Engineering
Contact: xileiw@stanford.edu, xju@stanford.edu

Motivation

Super-resolution reconstruction (SRR) generally relies on the assumption that estimation of sub-pixel motion in the scene is accurate. However, when there is inaccurately estimated motion within one of the existing SRR algorithms, it often produces undesirable results with disturbing artifacts.

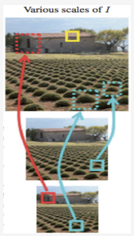


From EE367 class7 Computational Photography.pdf

The goal of our project is to implement, improve and compare SRR algorithms without explicit sub-pixel motion estimation.

Related Work

Glasner et. al [3] proposed a framework that combines Classical SRR and Example-based SRR.



From [3]

Recurrence of patches in the same image scale.

Low/high-resolution patch correspondences learned from recurrence across multiple image scales.

In [4], Zhang et. al proposed a MAP SRR framework that incorporates NLM and SKR prior terms.

Danielyan et. al. [5] proposed a framework using an algorithm BM3D to compensate lack of motion information.

Super-Resolution Reconstruction Algorithm

Super Resolution Reconstruction With Probabilistic Motion Estimation

- **Fusion Step:** $\varepsilon_{PML}^2(z) = \frac{1}{2}\sum_{m=1}^{M}\sum_{t=1}^{T}\left\|DF_m z - y_t\right\|_{W_{m,t}}^2$

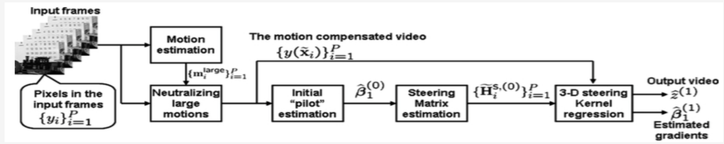
$$z[i,j] = \frac{\sum_{[k,l]\in N(i,j)}\sum_{t=1}^{T} W_{m,t}[k,l]\, y_t[k,l]}{\sum_{[k,l]\in N(i,j)}\sum_{t=1}^{T} W_{m,t}[k,l]}$$

$$W_{m,t}[i,j] = \exp\left\{-\frac{\left\|R_{i,j}(DF_m z - y_t)\right\|_2^2}{2\sigma^2}\right\}\cdot f\left(\sqrt{(dx(m))^2 + (dy(m))^2 + (t-1)^2}\right)$$

- **Deblurring Step with ADMM:** $\varepsilon_{DB}^2(x) = \left\|Hx - z\right\|_2^2 + \lambda \cdot TV(x)$

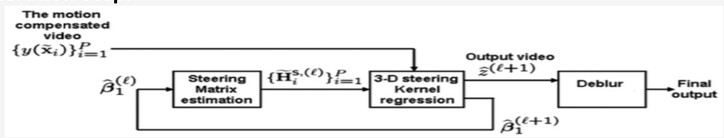
Super Resolution Reconstruction With Steering Kernel Regression

- **Initialization Step:**



From [2]

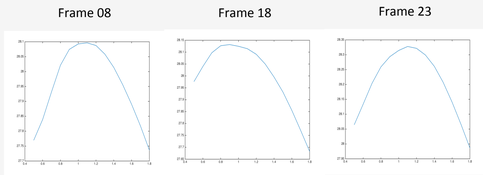
- **Iteration Step:**



From [2]

Simulation Results

- **Super Resolution Reconstruction With Probabilistic Motion Estimation**



PSNR Vs σ

- **Super Resolution Reconstruction With Steering Kernel Regression**

Foreman Sequence using SKR

Future Work

- **Try and compare different f functions in SRR with probability motion estimation to get better results**
- **Apply color TV in ADMM deblurring so that it can be used in RGB images**
- **Develop a SRR framework that combines probability motion estimation and steering kernel regression**

Reference

[1] M. Protter and M. Elad, "Super Resolution With Probabilistic Motion Estimation", IEEE Transactions on Image Processing, vol. 18, no. 8, pp. 1899-1904, 2009.
[2] H. Takeda, P. Milanfar, M. Protter and M. Elad, "Super-Resolution Without Explicit Subpixel Motion Estimation", IEEE Transactions on Image Processing, vol. 18, no. 9, pp. 1958-1975, 2009.
[3] D. Glasner, S. Bagon and M. Irani, "Super-resolution from a single image", 2009 IEEE 12th International Conference on Computer Vision, 2009.
[4] K. Zhang, X. Gao, D. Tao and X. Li, "Single Image Super-Resolution With Non-Local Means and Steering Kernel Regression", IEEE Transactions on Image Processing, vol. 21, no. 11, pp. 4544-4556, 2012.
[5] A. Danielyan, A. Foi, V. Katkovnik and K. Egiazarian, "Image and video super-resolution via spatially adaptive blockmatching filtering", in International Workshop on Local and Non-local Approximation in Image Processing, 2008.