Super Resolution of Light Field Images Using Linear Subspace Projection of Patch -Volumes

The algorithm learns linear projections between subspaces of reduced dimension in which reside patch volumes extracted from the light field,

論文提到的其他SR方法，

一，對渲染的images做SR：

F. Nava and J. Luke, “Simultaneous estimation of super-resolved depth and all-in-focus images from a plenoptic camera,”

D. Cho, M. Lee, S. Kim, and Y.-W. Tai, “Modeling the calibration pipeline of the Lytro camera for high quality light-field image reconstruction,”

二、對LF的spatial和angular都做SR、

T. E. Bishop, S. Zanetti, and P. Favaro, “Light field superresolution,”用Bayesian framework估算LF HR

S.Wanner and B. Goldluecke, “Variational light field analysis for disparity estimation and super-resolution, 2014”用disparity map合成SR

K.Mitra and A.Veeraraghavan, “Light field denoising, light field superresolution and stereo camera based refocusing using aGMMlight field patch prior,”用patched based的技術來增強SR，linear minimum mean square error來算4D的patches，假設GMM for patch structure，

N. K. Kalantari, T.-C. Wang, and R. Ramamoorthi, “Learningbased view synthesis for light field cameras,”用DCNN並且還有利用disparity information，

此篇論文使用的是example-based spatial super resolution technique，作用在2D-patches的3D stack，

從一組高跟低解析度的training data，提取patch-volumes，(q\*q\*n)，n為sub-aperture數，q為patch邊長，再用PCA(principal component analysis主成分分析)把patch投影到subspace，用Multivariate Ridge Regression來學習Patch-volumes HR跟LR的對應關係，之後LR的patch-volume就可以用這個RR來super resolve。

2D collocated patches形成的patch-volume是對齊的，但有些LF image有大disparity，就會使用block matching，讓patch-volume是用best-matching patch形成，不一定是單純用collocated patches，

用multi-linear models來做angular SR，

比較對象：

1. T. Peleg and M. Elad, “A statistical prediction model based on sparse representations for single image super-resolution,”
2. “C. Dong, C. C. Loy, K. He, and X. Tang, “Image super-resolution using deep convolutional networks,”
3. “K. Zhang, B. Wang, W. Zuo, H. Zhang, and L. Zhang, “Joint learning of multiple regressors for single image super-resolution,””

**V***s,t ∈* R*X,Y*， V代表sub-aperture，XY是每個sub-aperture的維度，st是sub-aperture對應的位置，*patch-volume* **p***j ∈* R*q,q,n* patch每個q\*q共有n個， (*xcj , ycj* )是patch 中心pixel的座標，

**V***L* = Θ**V***H* + ***η，η為雜訊，***Θ為模糊kernal和downsample α 倍的operator。

Testing phase把low quality light field做bicubic內插變成跟high quality一樣大，從高低quality image，取q\*q位置重疊(overlap)的patches共floor(q/3)個

Manifolds：當作是一個overlapping的image set

此篇使用的patch reconstruction approach，學習一個mapping function在low and high resolution sub-space之間。

學習mapping relation是non trivial，因為patch-volume的dimension太大，但光場照片之間有許多冗餘資訊，可以省略掉來降低維度。利用PCA，

PCA：

**C***L* = **LLT** **C***H* = **HH**T，先算CL, CH，再用eigen-decomposition得到EL, EH，EL,EH為正交矩陣所以對patch volume做投影不會改變資訊，然後再取EL,EH的第一個column(eigen value最大的)，把維度再降低，但損失一些比較不重要的資訊，得到patch-volume subspace。

LR->HR是一個線性回歸轉換，但Z\*Z太大，所以改成計算subspace，從coupled dictionaries L,H，轉到LH對應的subspace，