Tree-Structured Algorithm For Efficient Shearlet-domain Light Field Reconstruction

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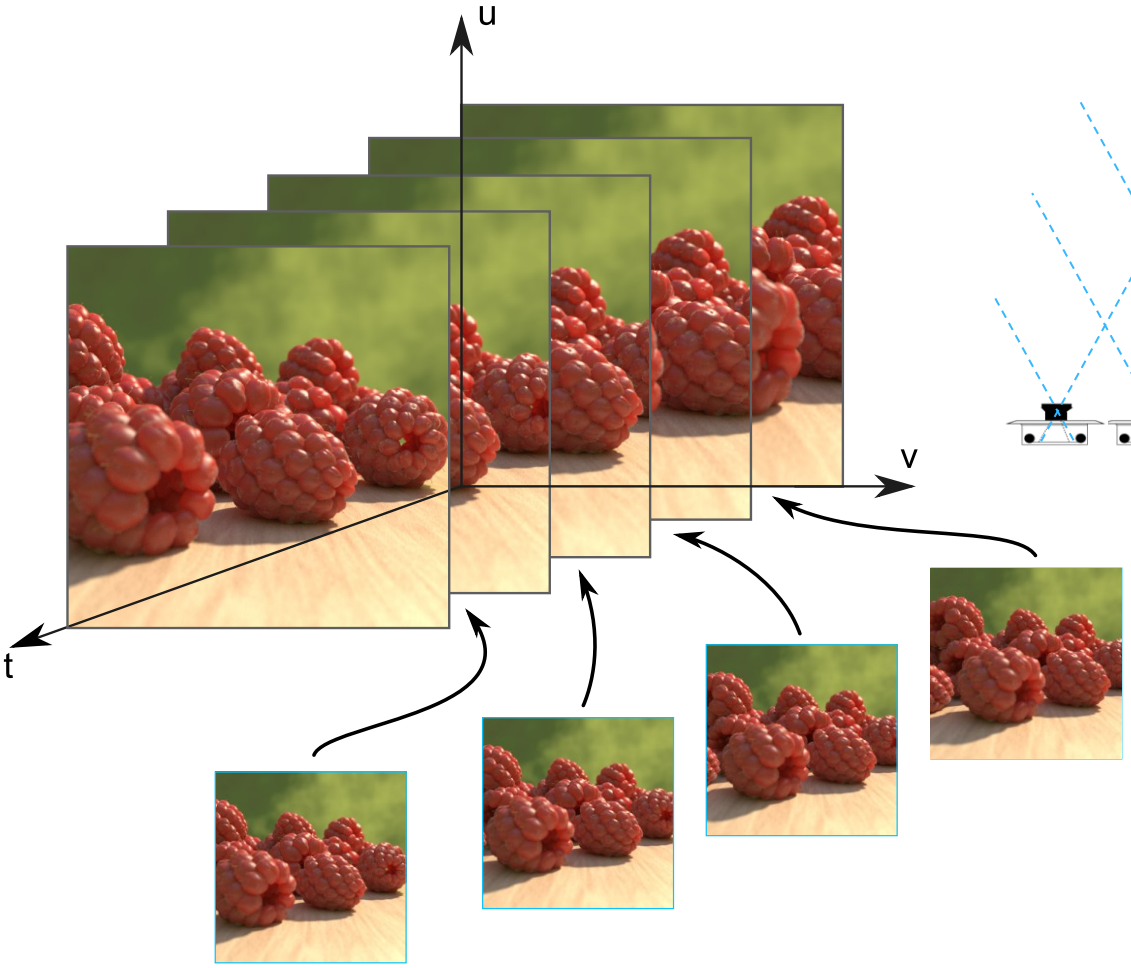
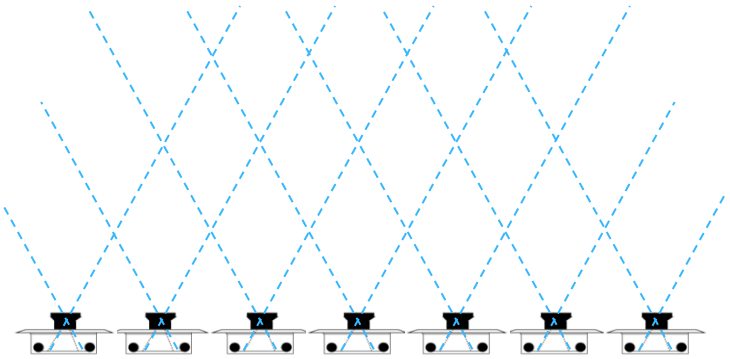
Outline

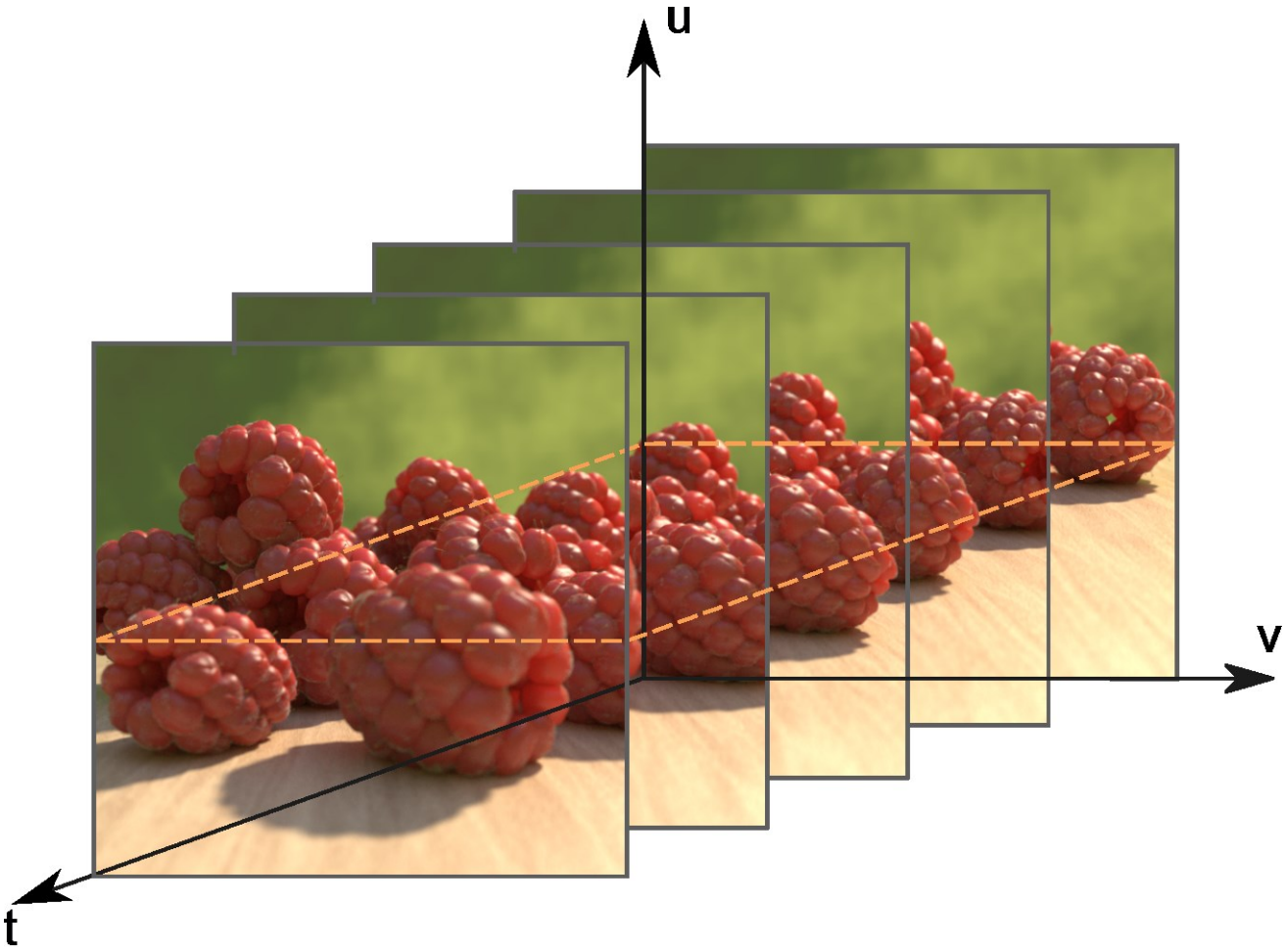
- Problem formulation
  - Light Filed reconstruction algorithm in epipolar-plane image domain using shearlet transform
- Two tree-structured algorithms for acceleration of the reconstruction utilizing epipolar images' similarity.
- Reconstruction results and evaluation

Problem Formulation



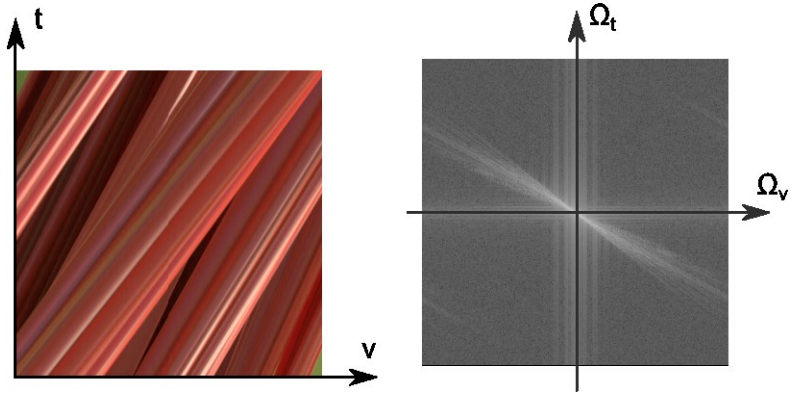


Light Field Reconstruction



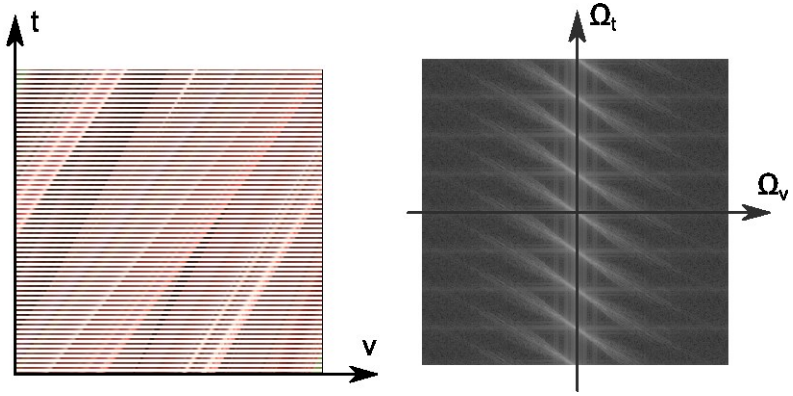
Epipolar-plane image

Densely sampled



Spatial domain Frequency domain

Coarsely sampled

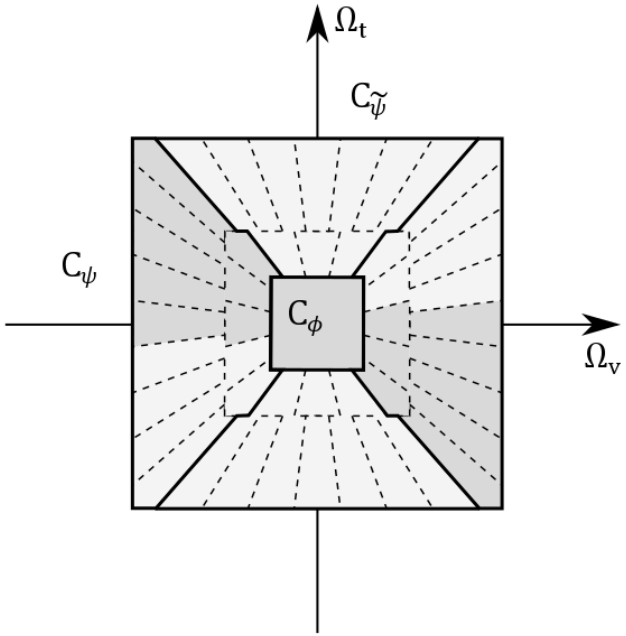


Spatial domain Frequency domain

$$\Delta d_{max} = \frac{f}{z_{min}} \Delta t \leq 1$$

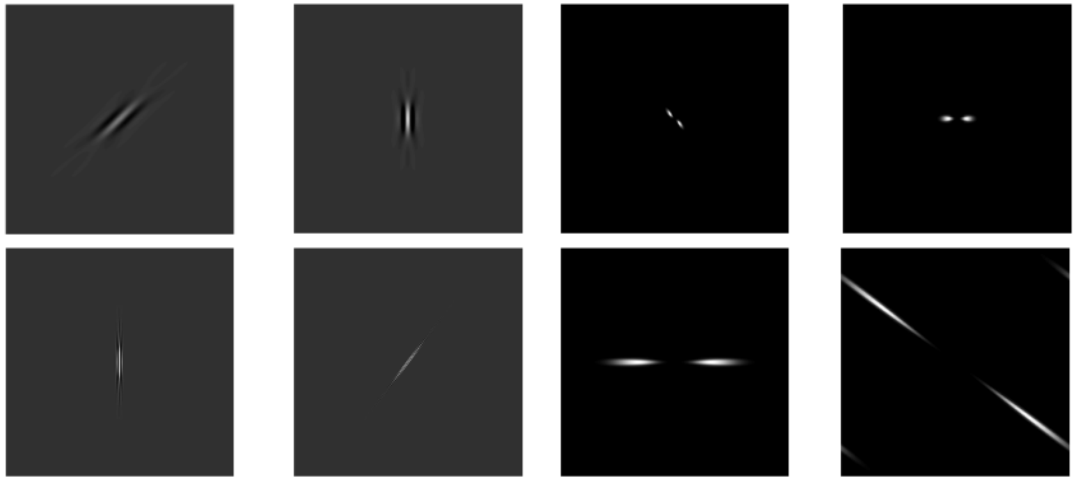
Discrete Shearlet Transform

Disparity based frequency domain separation



Spatial domain

Frequency domain



EPI Reconstruction Algorithm

g - measured incomplete data
H - corresponding mask of known samples
S, S^* - shearlet analysis and synthesis transforms

$g = Hf^*$ and $S(f^*)$ is sparse

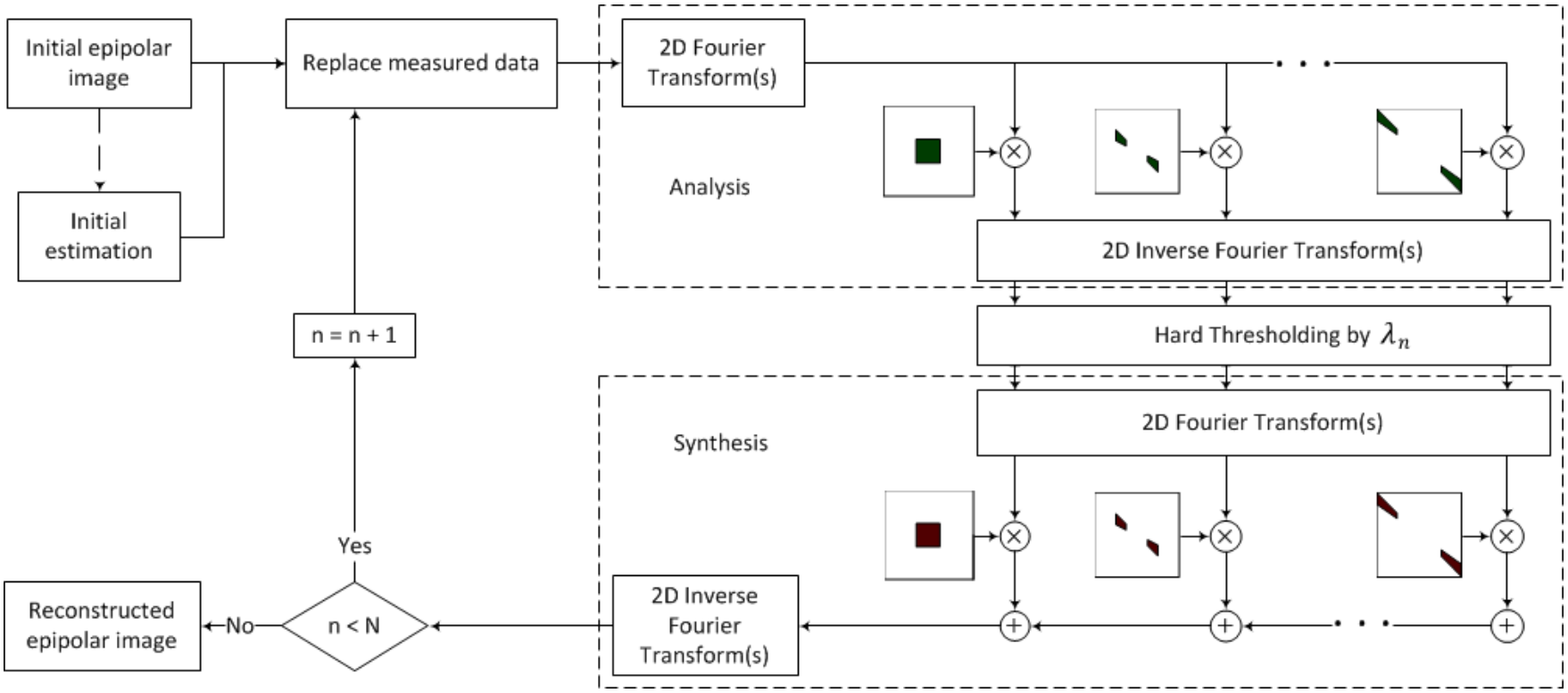
Iterative Hard Thresholding

$$f_{n+1} = S^*\left(H_{\lambda_n}\left(S(f_n + \alpha(g - Hf_n))\right)\right)$$

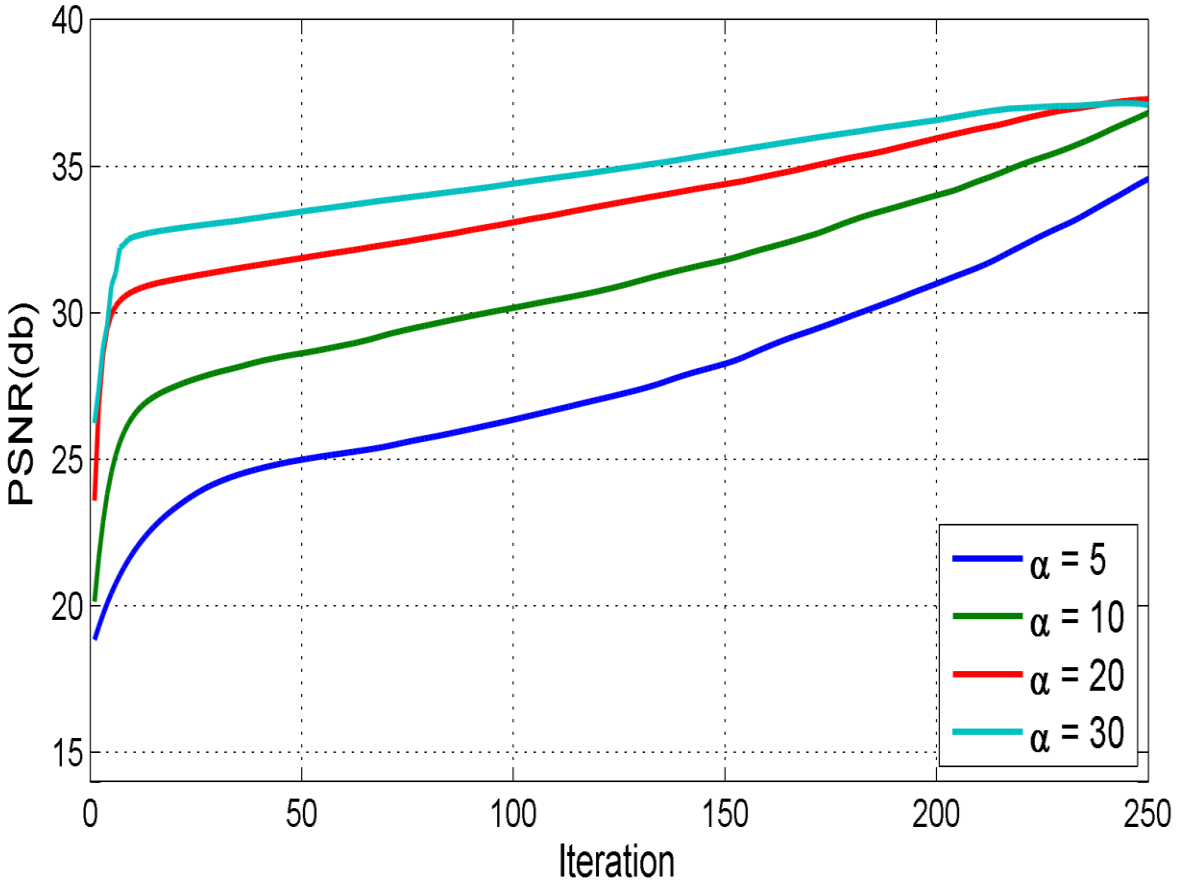
$$H_\lambda(x) = \begin{cases} x, |x| \geq \lambda \\ 0, |x| < \lambda \end{cases}$$ hard thresholding operator

$$\lambda_n = (\lambda_{\max} - \lambda_{\min})\frac{n}{L} + \lambda_{\min}$$ iteratively decreasing threshold

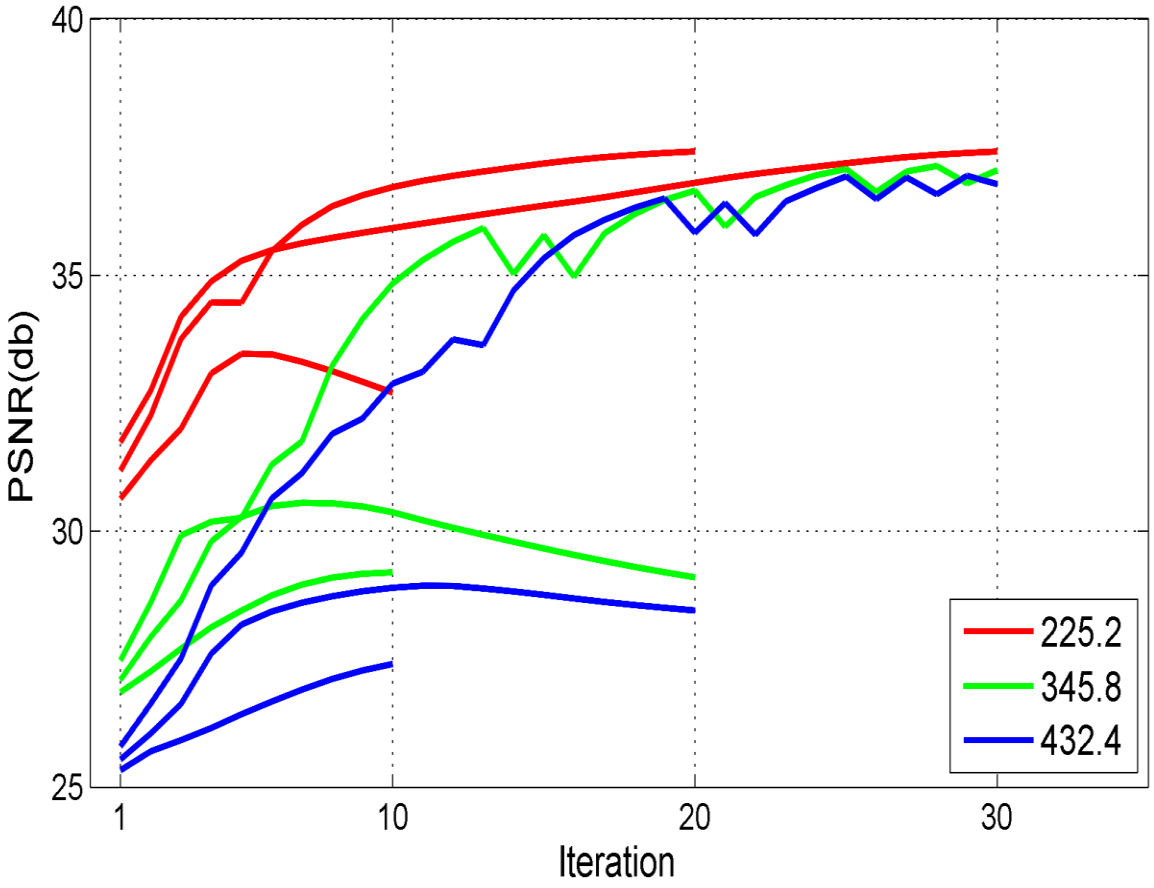
EPI Reconstruction Algorithm



α parameter selection



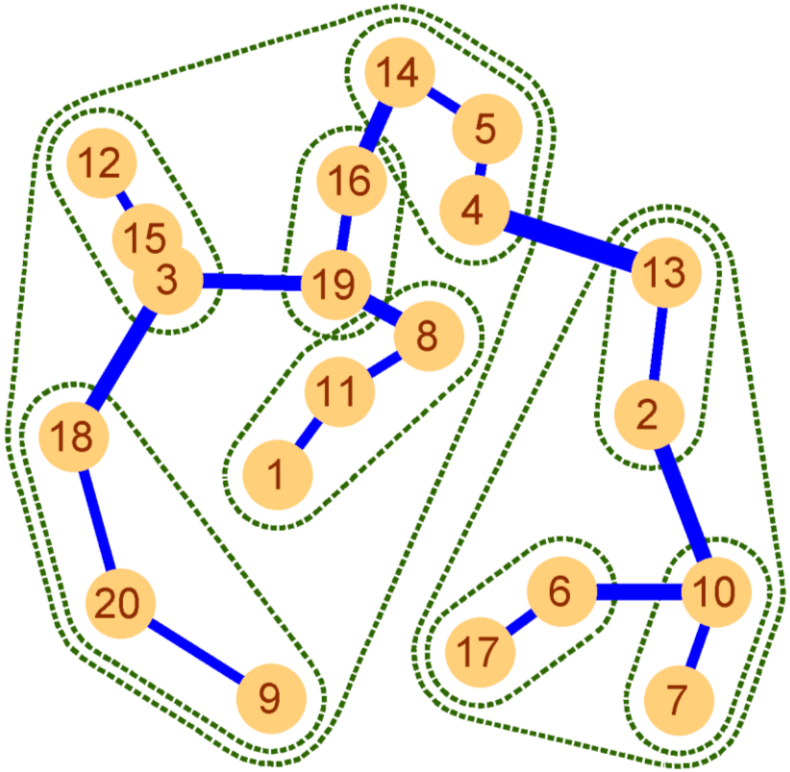
Initial estimation distance



Reconstruction order

- Independent reconstruction of EPIs is highly parallelizable
- For given set of view in which order to process EPI reconstruction algorithm to utilize similarity between EPIs and still keep independent processing for given M processing units?
- Construct tree-structured processing order to utilize either similarity between EPIs or number of given processing units

Algorithm I


14
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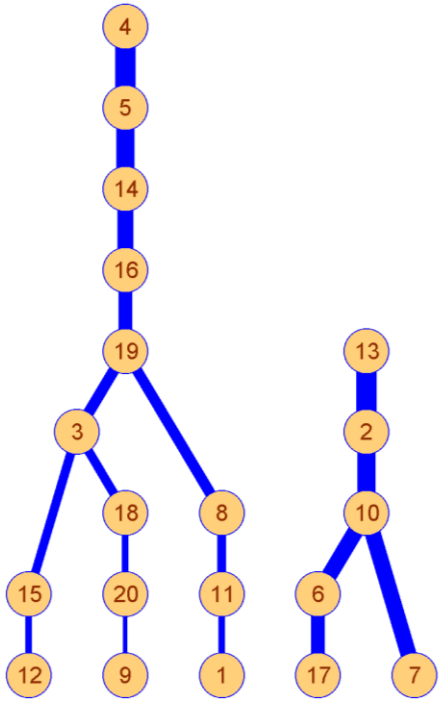
4
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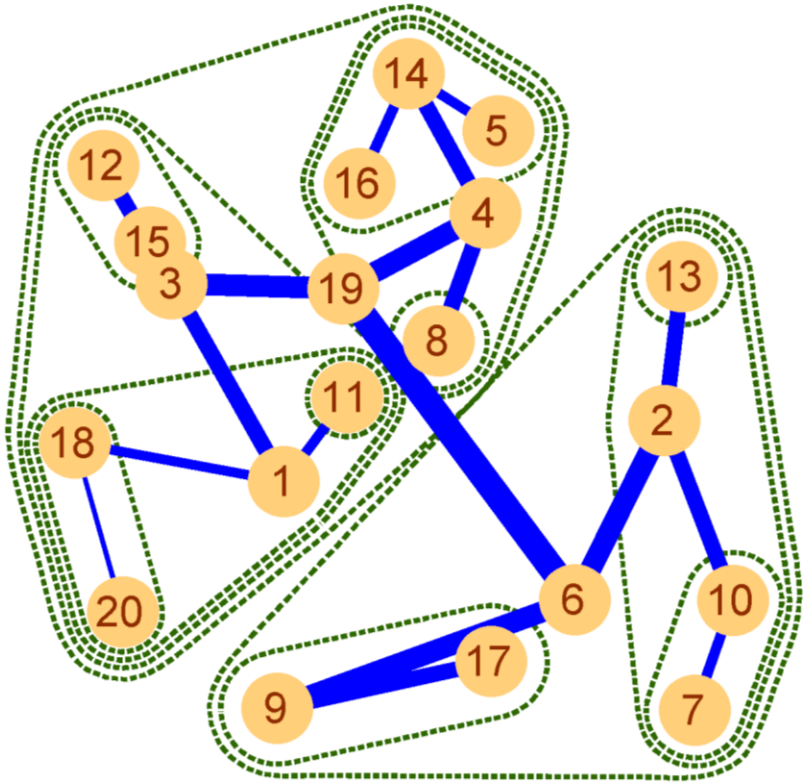
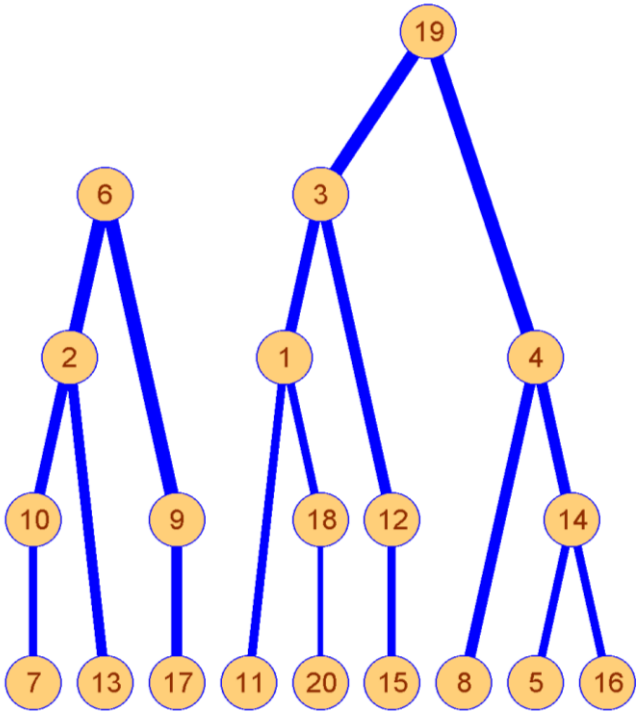
Algorithm II





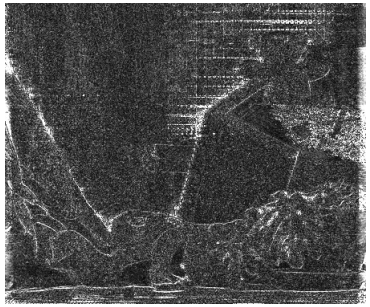
Reconstruction Results

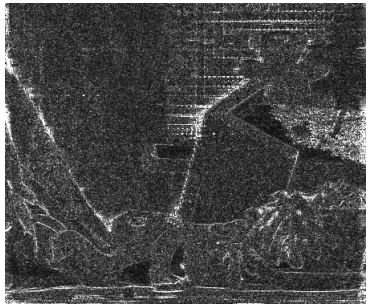
Ground Truth

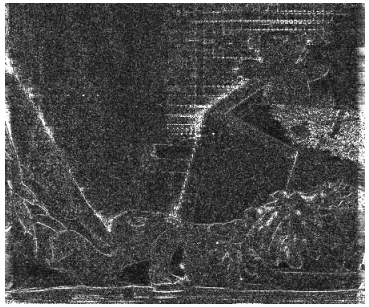
Independent reconstruction

Algorithm I

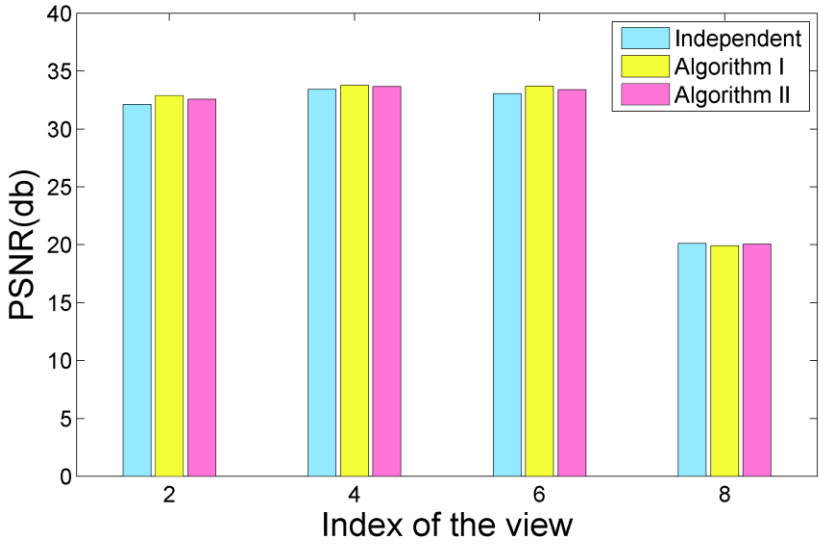
Algorithm II







Acceleration



	Red channel	Green channel	Blue channel
Algorithm I	0.622	0.652	0.652
Algorithm II	0.758	0.782	0.774

Summary

- Presented two tree-structured processing algorithms for accelerating LF reconstruction
  - Algorithm I is optimized for maximizing usage of similarity between EPIs
  - Algorithm II is optimized for using M-node paralyzed computation as well as taking into account similarity between EPIs
- For both algorithms, there is a negligible difference between reconstruction results with significantly decreased computation time