Usableness improving for the nonlocal means image denoising algorithm to use it on low-powered embedded computing units

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Nonlocal means (NL-means) image denoising algorithm

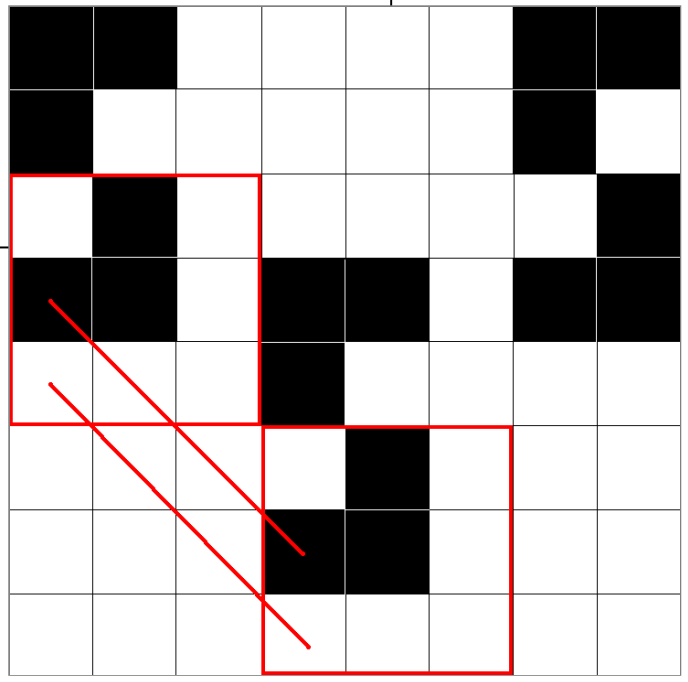
2005г., A. Buades, B.Coll, and J.M.Morel, “A review of image denoising algorithms, with a new one”, SIAM Interdisciplanary Journal, vol.4, no.2

NL-means principles

$$NL(v)(i) = \sum_{j \in I} \omega(i,j)\, v(j)$$

$$\omega(i,j) = \frac{1}{Z(i)} e^{\frac{-\|v(N_i) - v(N_j)\|^2_{2,a}}{h^2}}$$

$$Z(i) = \sum_{j} \omega(i,j)$$



Benefits and problems

- High-effective denoising which save small details and textures
- Computationally Expensive

Ways to solve this

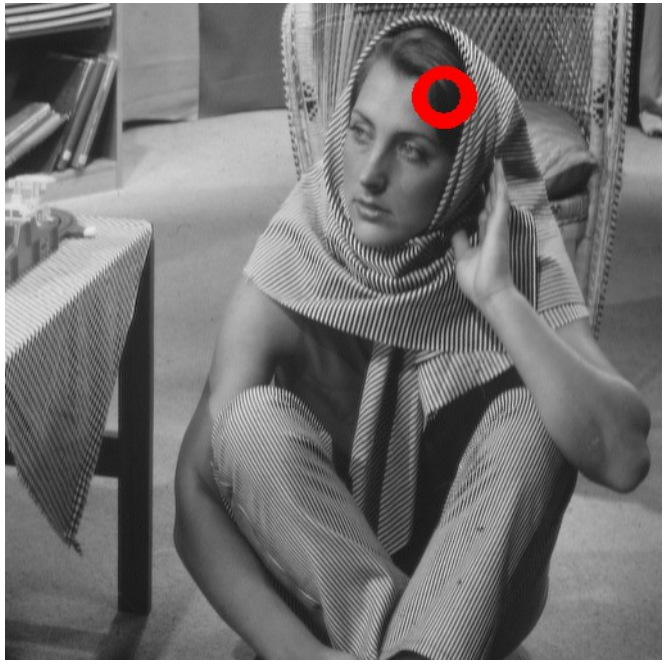
- GPU – shaders using
- Masks using, weight symmetry using
- Patch preselecting

Statistical patch preselecting

M. Mahmoudi and G. Sapiro,“Fast image and video denoising via nonlocal means of similar neighborhoods,” Signal Processing Letters, vol. 12, no. 12, pp. 839–842, 2005.

Patch classification by the following features:

- Average mean
- Average gradient direction



Patch preselecting by binary tree building

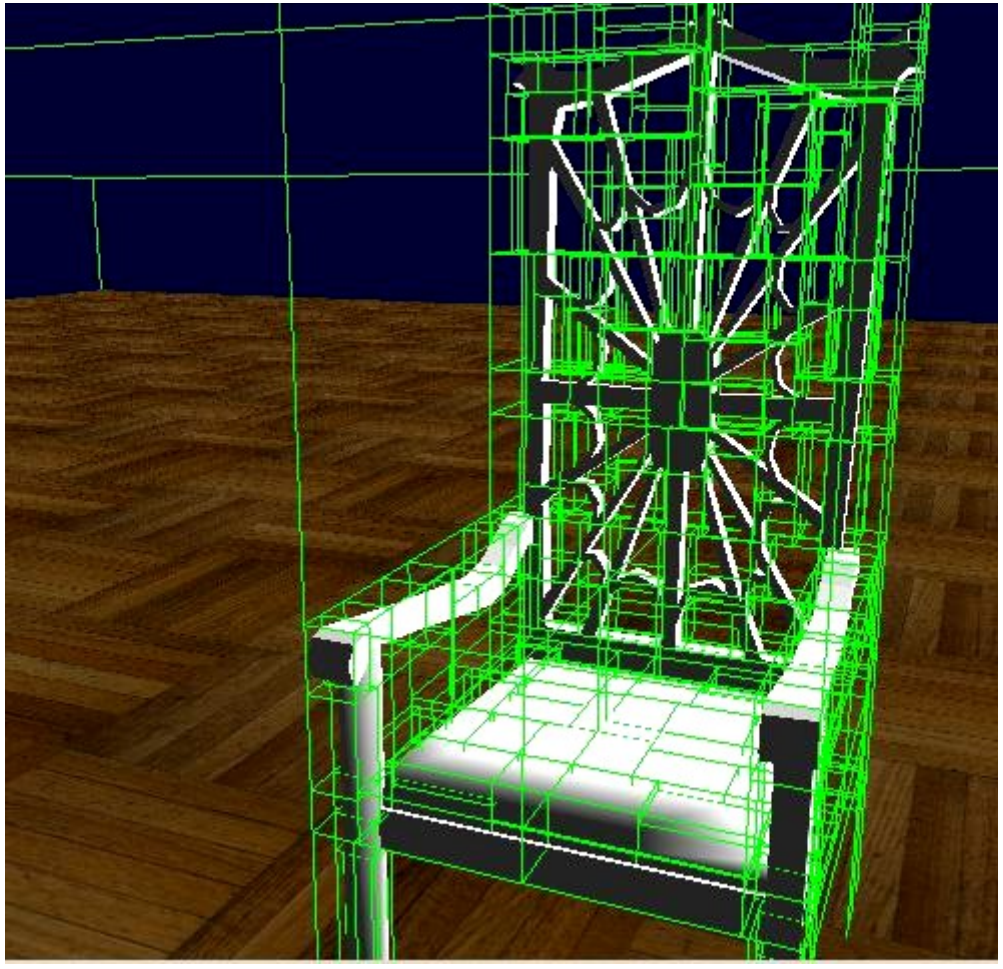
O. Kleinschmidt, T. Brox and D. Cremers,

“Efficient nonlocal means for denoising of textural patterns,”

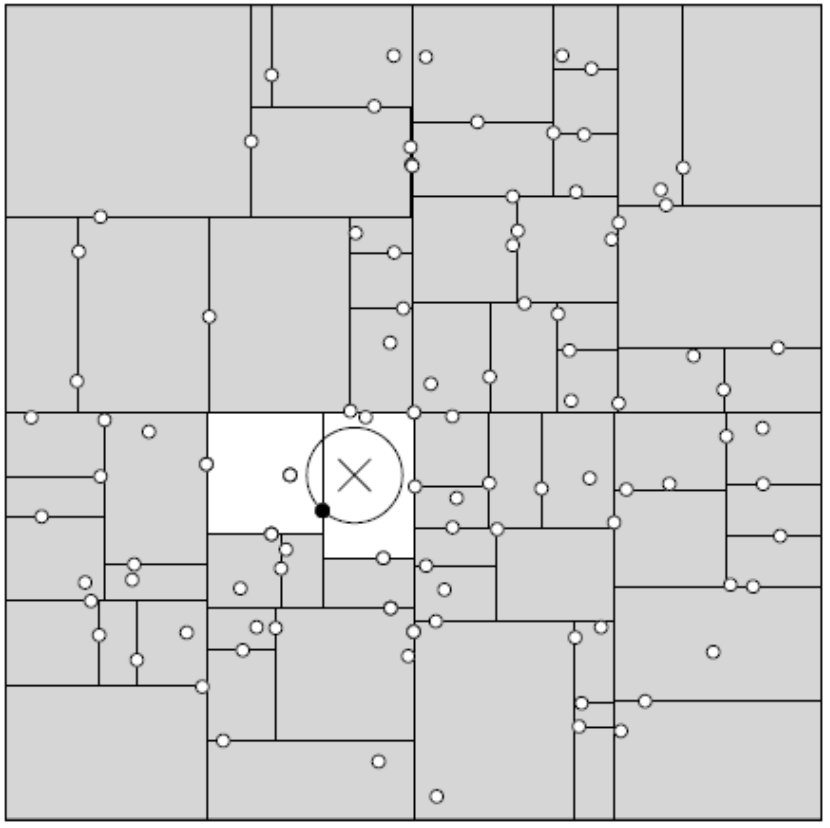
IEEE Transactions on Image Processing, vol. 17, no. 7, July 2008.

- Proposed the iterational nonlocal means algorithm
- To accelerate the denoising process – build tree-like structure with patches which intended to further averaging. The tree build just **AT ONCE**

Kd-tree



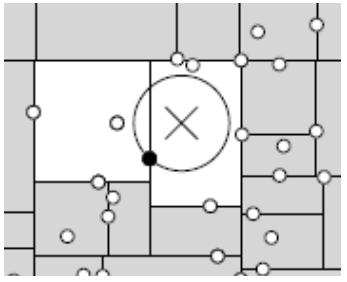
3D



2D

kd-tree usage effect

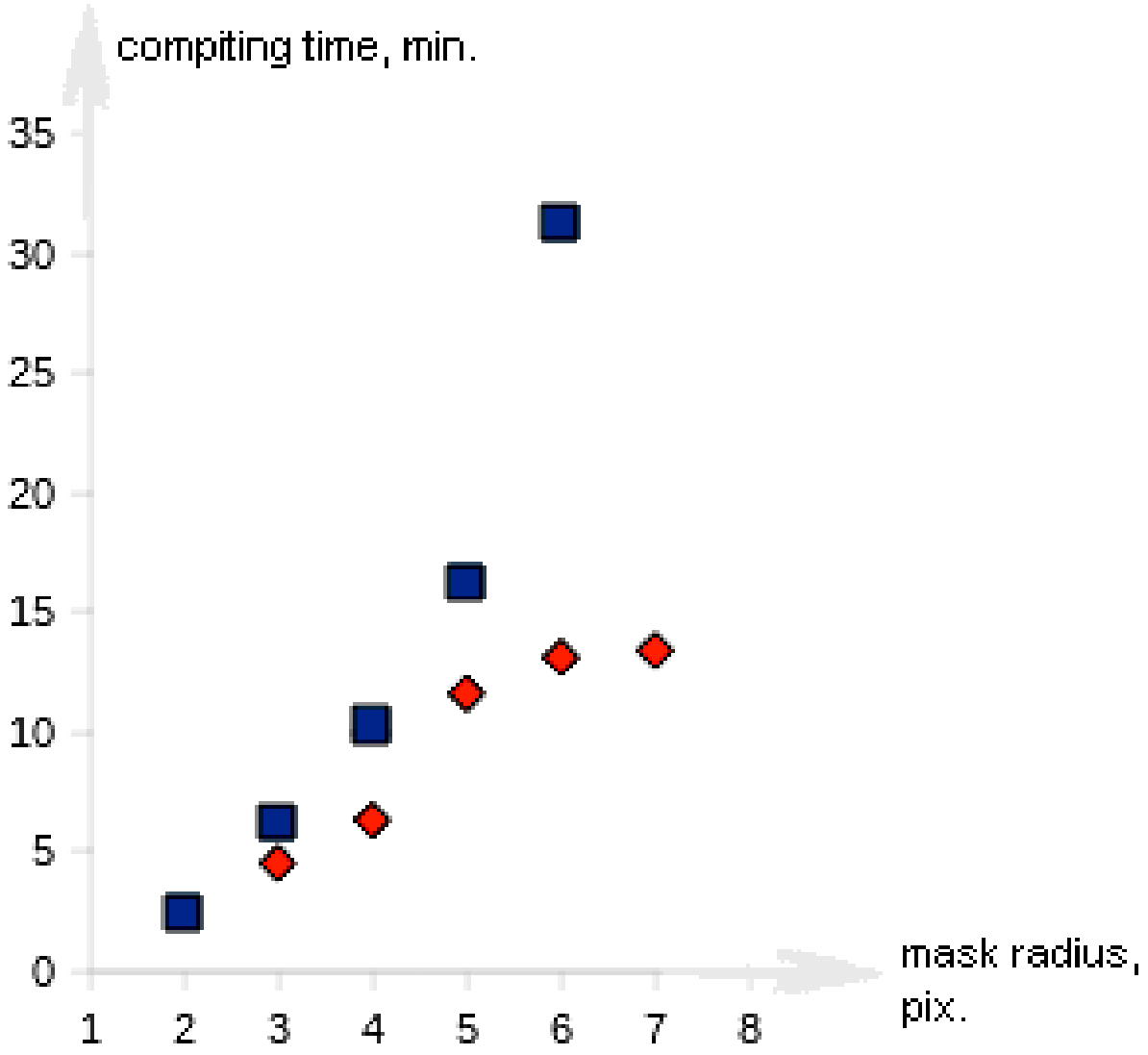
- We have separated small patches groups
- We have not more then 2d leafs patches to average mutually



$$NL(v)(i)=\sum_{j\in I}\omega(i,j)\,v(j)$$

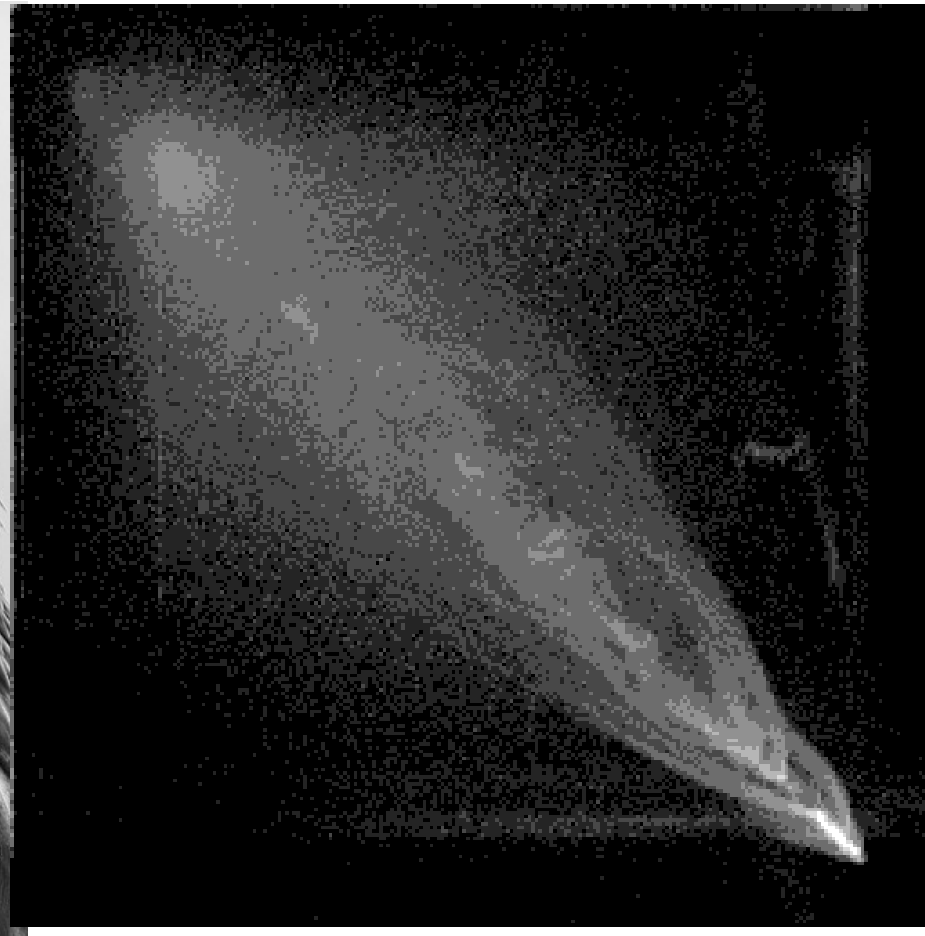
where *I* is similar patches subset

Dependence computing time of mask radius



– original
– accelerated by tree

kd-space projections



Current plans

- rotate kd-space before kd-tree building
- use GPU
- revise tree-like structure to use

This project has suggested for the У.М.Н.И.К. contest (improving photographying quality for mobile phones).

Thank you!

Q & A