

Multi-Scale Feature-Preserving Smoothing of Tomographic Data

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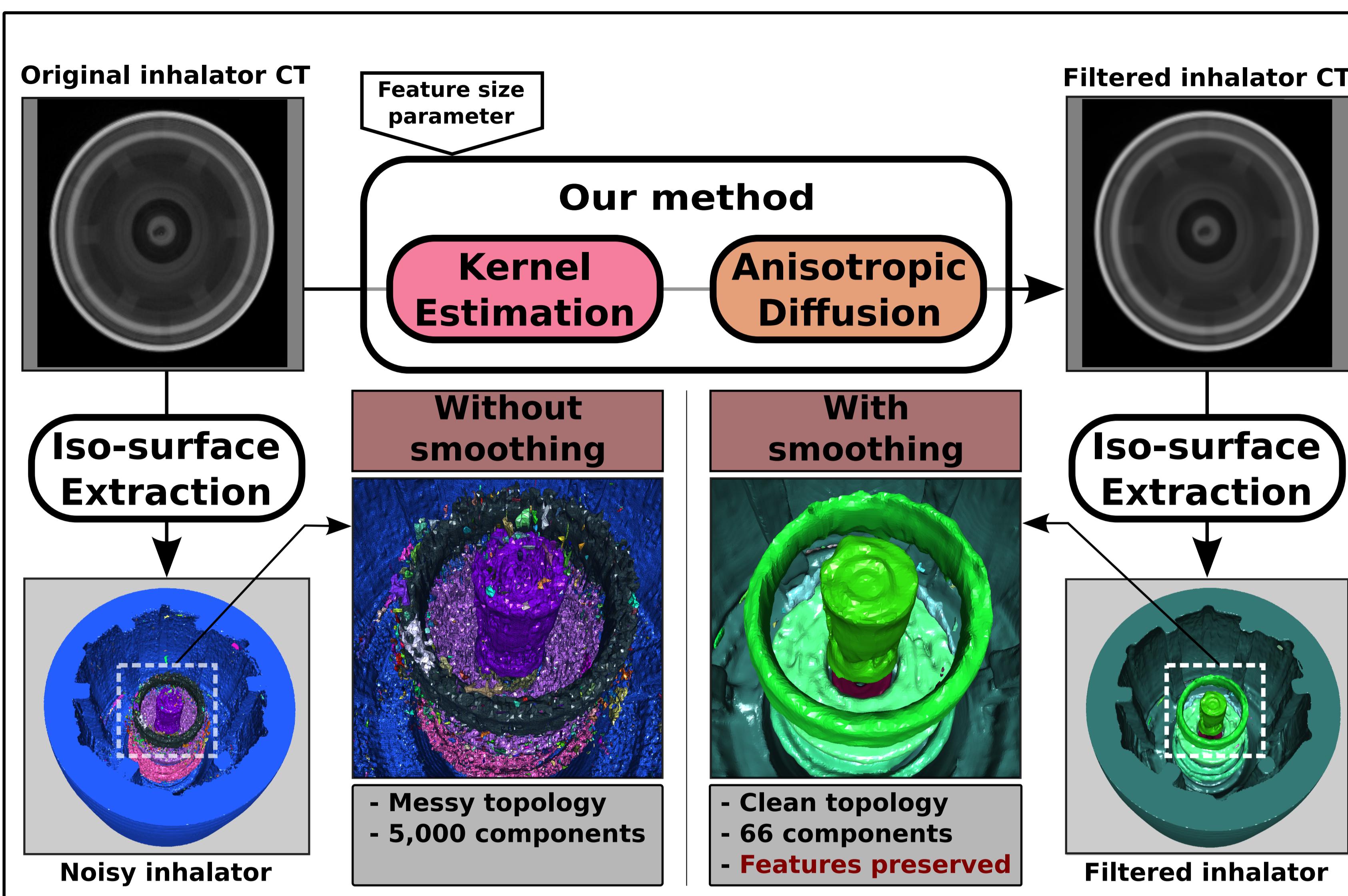
Inputs: Volume Computer Tomography

Sources

- Medical imaging
- Reverse engineering
- Cultural heritage

Problems

- Noise from reconstruction
- Messy and complex topology



Anisotropic Diffusion

$$\frac{\partial f}{\partial t} = \operatorname{div}(M(x)\nabla f)$$

$M(x)$ = diffusion tensor

Kernel Estimation

$$M(x) = \frac{1}{C} \int h_x(\omega) M_g(\omega) d\omega$$

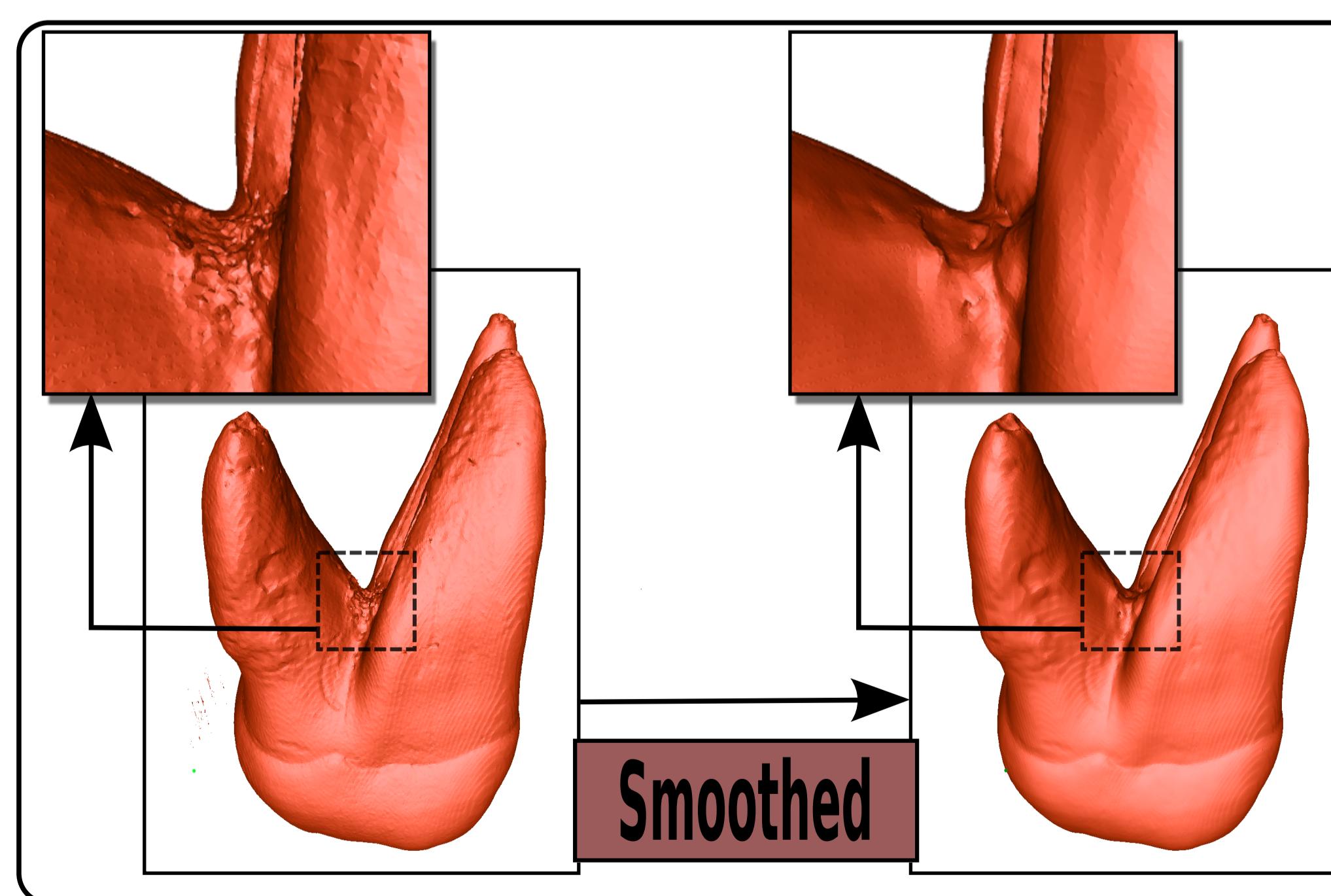
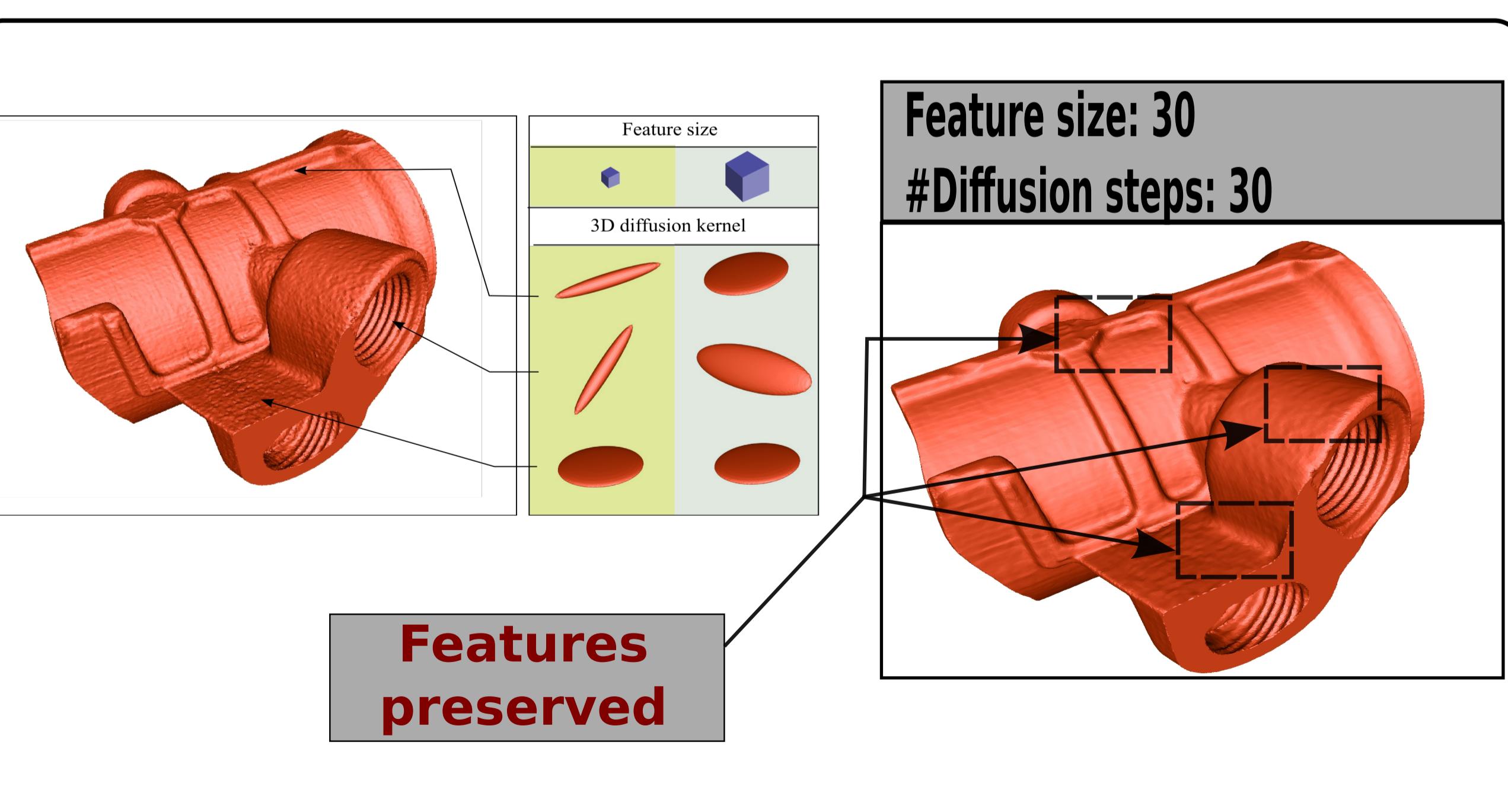
where $h_x(\omega) = g \otimes K(f)$

$$M_g(x) = R_{-\omega} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & \frac{1}{\epsilon} \end{bmatrix} R_\omega$$

w = gaussian locality
C is constant

GPU Implementation

- Embarrassingly parallel problem
- CT is voxelized
- SIMD (Single Instruction Multiple Data)



Computing Time

Feature size	Volume size		
	100^3	200^3	300^3
5^3	2.64 sec	20.03 sec	77.43 sec
10^3	2.64 sec	20.03 sec	136.95 sec
20^3	2.64 sec	20.03 sec	220.94 sec

The time difference between the feature sizes in the volume 300^3 is due to the segmentation of the volume.

Diffusion steps	Volume size		
	100^3	200^3	300^3
1	0.09 sec	0.72 sec	4.45 sec
50	0.18 sec	1.64 sec	9.86 sec

References

- FRANGAKIS, A. S., AND HEGERL, R. 2001. Noise reduction in electron tomographic reconstructions using nonlinear anisotropic diffusion.
- KASS, M., AND SOLOMON, J. 2010. Smoothed local histogram filters.
- SCHAAP, M., SCHILHAM, A., ZUIDERVELD, K., PROKOP, M., VONKEN, E.-J., AND NIJSEN, W. 2008. Fast noise reduction in computed tomography for improved 3-d visualization.

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