Medical Image Processing for Diagnostic Applications

Iterative Reconstruction – Resolution and Noise

Online Course – Unit 62

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Topics

Iterative Reconstruction Methods: Resolution

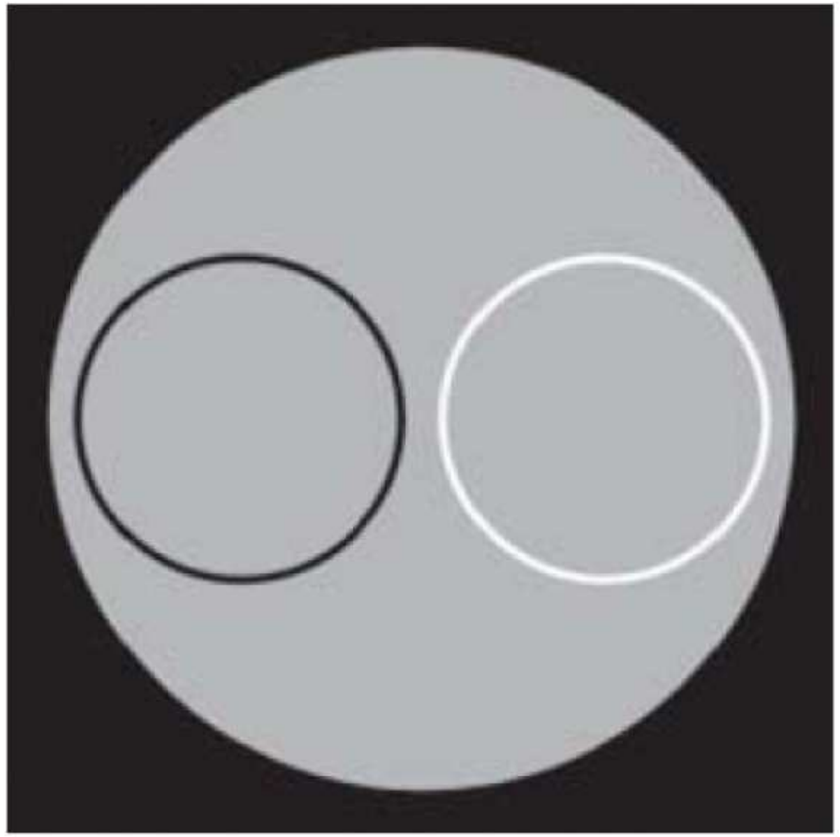

Figure 1: Phantom (Zeng, 2009)

Iterative Reconstruction Methods: Resolution

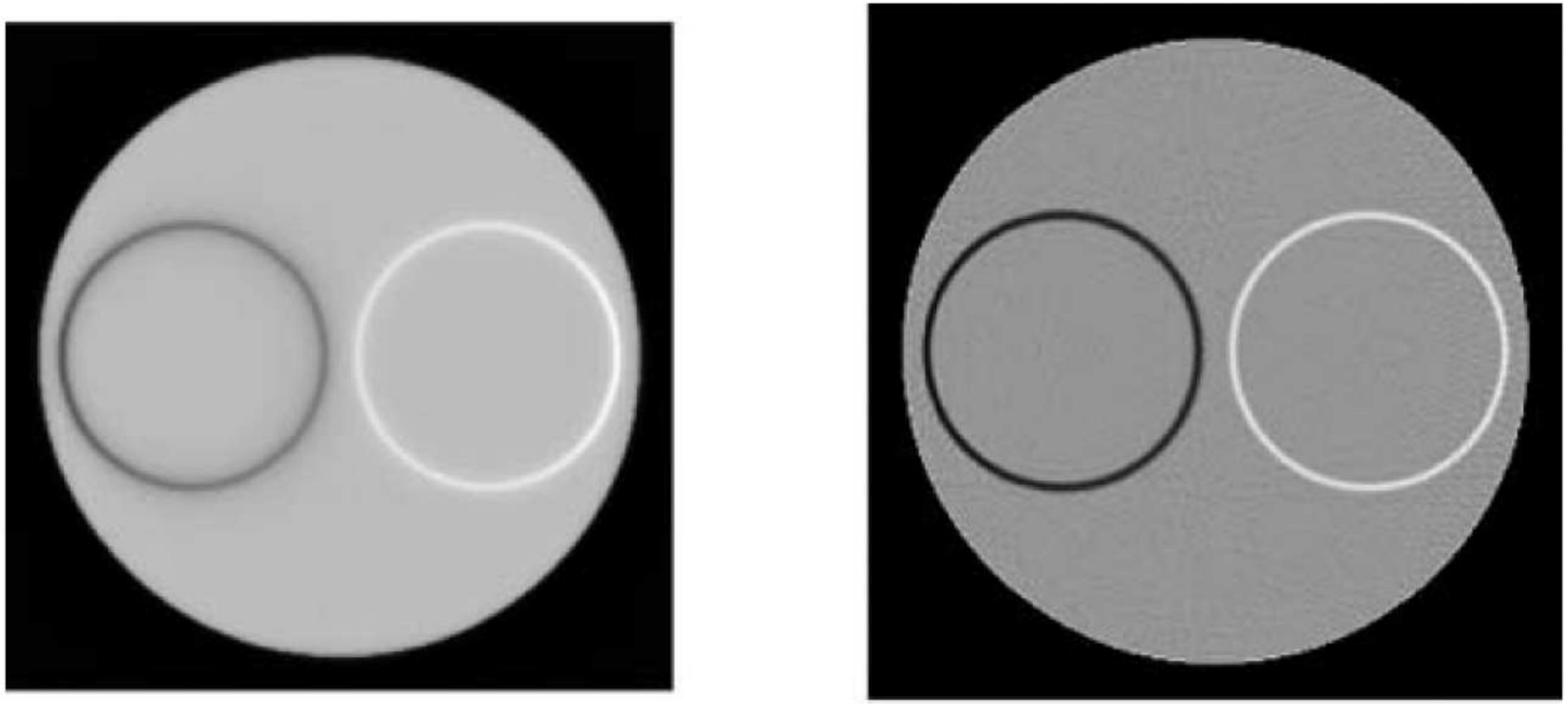

Figure 2: 25 iterations (left), 250 iterations (right) (Zeng, 2009)

Iterative Reconstruction Methods: Resolution

- Iterative methods do not necessarily have a uniform image resolution.
- Resolution increases with the number of iterations.
- This makes image quality assessment difficult.

Iterative Reconstruction Methods: Noise

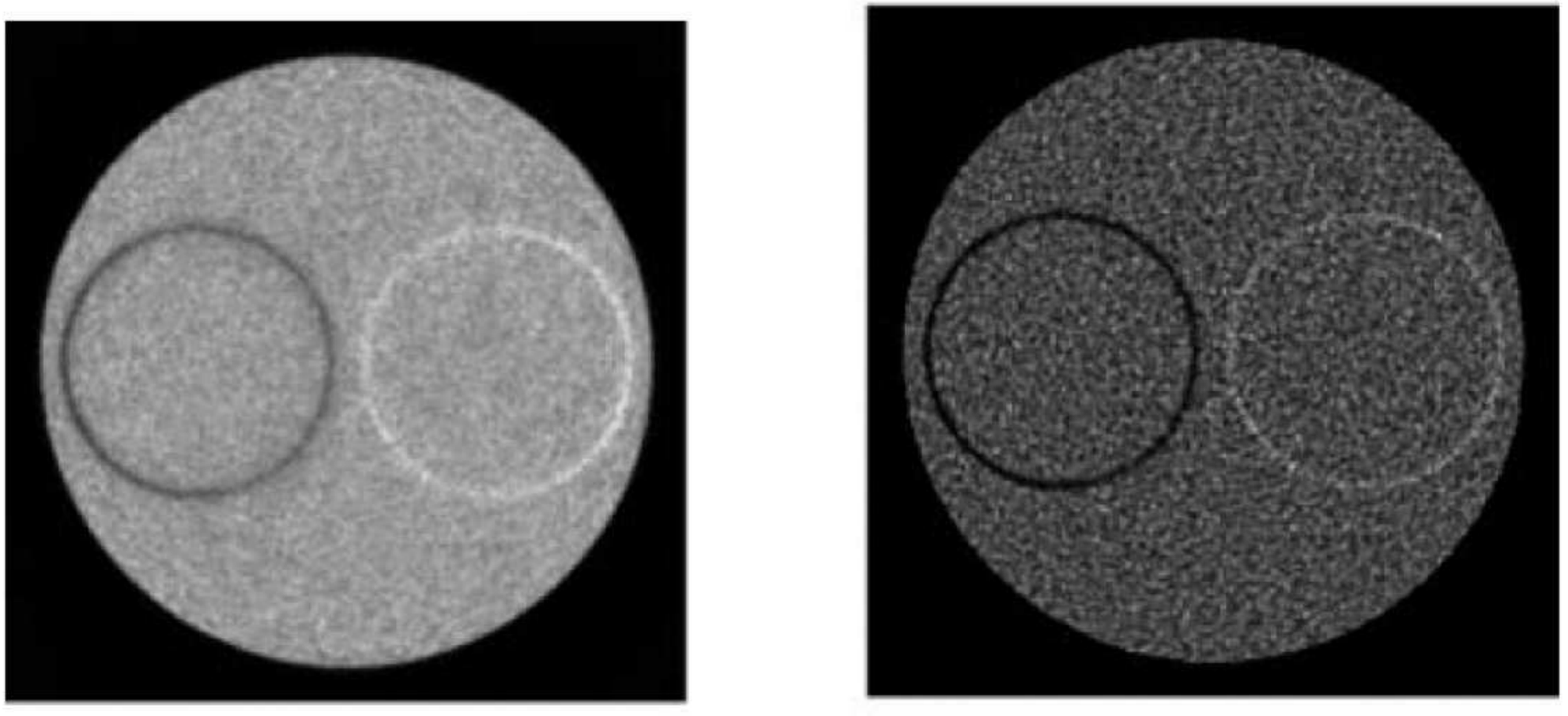

Figure 3: 25 iterations (left), 250 iterations (right) (Zeng, 2009)

Iterative Reconstruction Methods: Noise

- Image noise is dependent on the number of iterations.
- The more iterations, the more noise is in the image.
- A common means to control noise is to adjust the number of iterations.
- This is yet another reason why it is difficult to measure image quality in iterative methods.

Iterative Reconstruction Methods: Noise

Overiteration plus low-pass filtering can help to make the image resolution more uniform:

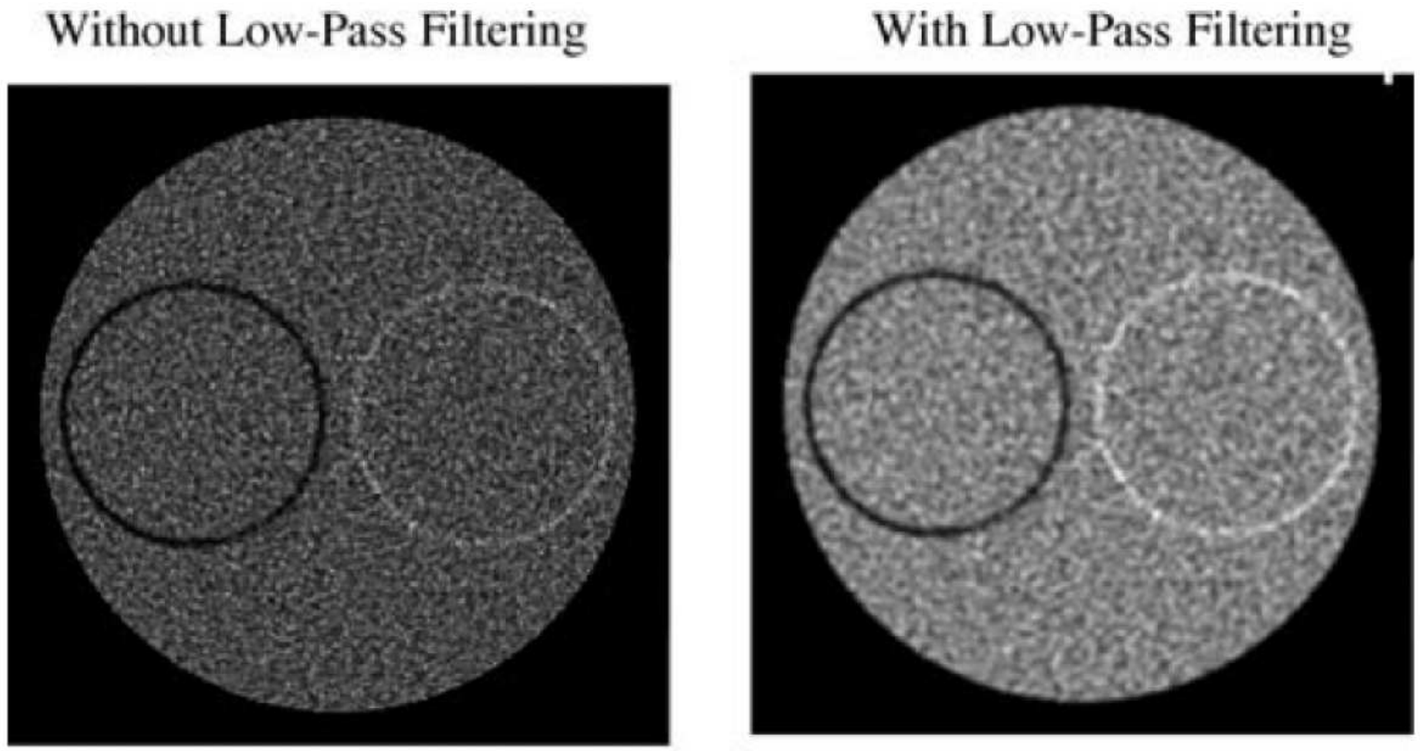

Figure 4: Low-pass filtering effect on reconstruction result (Zeng, 2009)

Topics

Take Home Messages

[Unit:]

- Resolution and noise are important aspects in iterative reconstruction and both are dependent on the number of iterations.
- Image quality assessment for iterative reconstruction remains challenging.

[Chapter:]

- Iterative reconstruction allows the definition of very flexible objective functions and therewith very flexible modeling of the imaging system.
- Analytic reconstruction methods are still often used, not least because superior image quality has not yet been shown for many applications.

Further Readings

References and related books for the discussed topics in iterative reconstruction:

Gengsheng Lawrence Zeng. *Medical Image Reconstruction – A Conceptual Tutorial*. Springer-Verlag Berlin Heidelberg, 2010. DOI: 10.1007/978-3-642-05368-9

Stefan Kaczmarz. “Angenäherte Auflösung von Systemen linearer Gleichungen”. In: *Bulletin International de l’Académie Polonaise des Sciences et des Lettres. Classe des Sciences Mathématiques et Naturelles. Série A, Sciences Mathématiques* 35 (1937), pp. 355–357 For this article you can find an English translation here (December 2016).

Avinash C. Kak and Malcolm Slaney. *Principles of Computerized Tomographic Imaging*. Classics in Applied Mathematics. Accessed: 21. November 2016. Society of Industrial and Applied Mathematics, 2001. DOI: 10.1137/1.9780898719277. URL: http://www.slaney.org/pct/

H. Bruder et al. “Adaptive Iterative Reconstruction”. In: *Medical Imaging 2011: Physics of Medical Imaging*. Ed. by Norbert J. Pelc, Ehsan Samei, and Robert M. Nishikawa. Vol. 7961. Proc. SPIE 79610J. Feb. 2011, pp. 1–12. DOI: 10.1117/12.877953