

# Medical Image Processing for Diagnostic Applications

## Modalities – X-ray Computed Tomography

Online Course – Unit 51

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Pattern Recognition Lab (CS 5)



# Topics

## X-ray Computed Tomography

### Summary

Take Home Messages

Further Readings

# X-ray Imaging

- X-rays penetrate the object of interest.
- The amount of absorption and scattering allows the estimation of the object density.
- Energy is absorbed in the object.

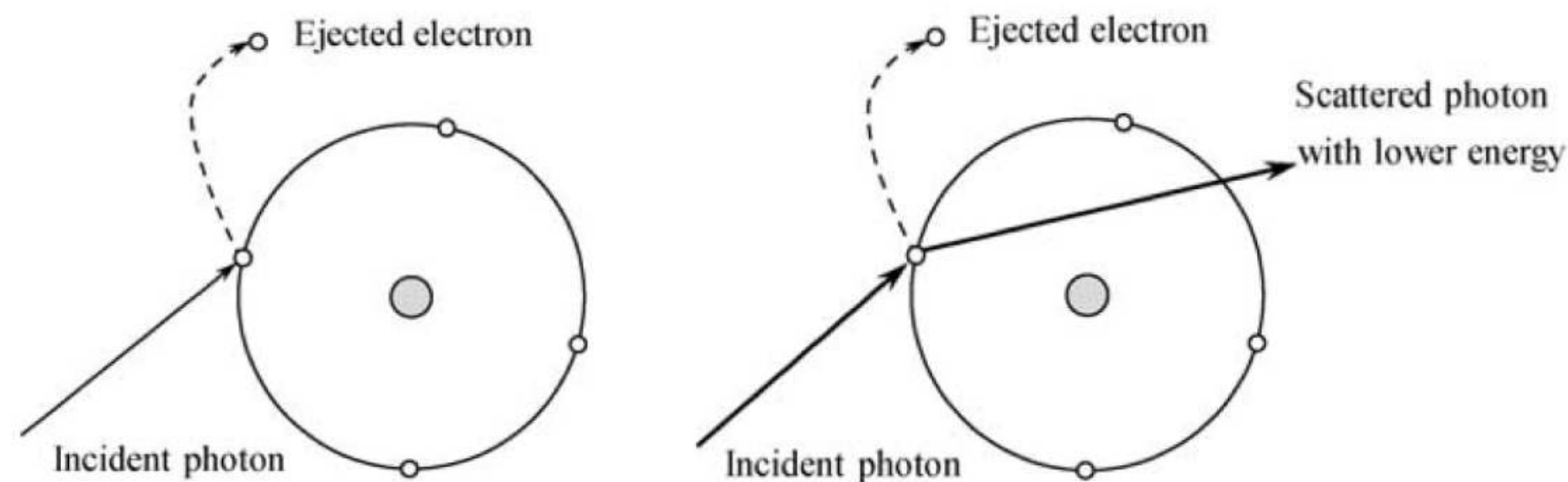


Figure 1: Photoelectric effect (left) and Compton scatter (right) (Zeng, 2009)

# Parallel Beam Geometry

- Earliest acquisition scheme
- **Principle:** “Rotate & Translate”

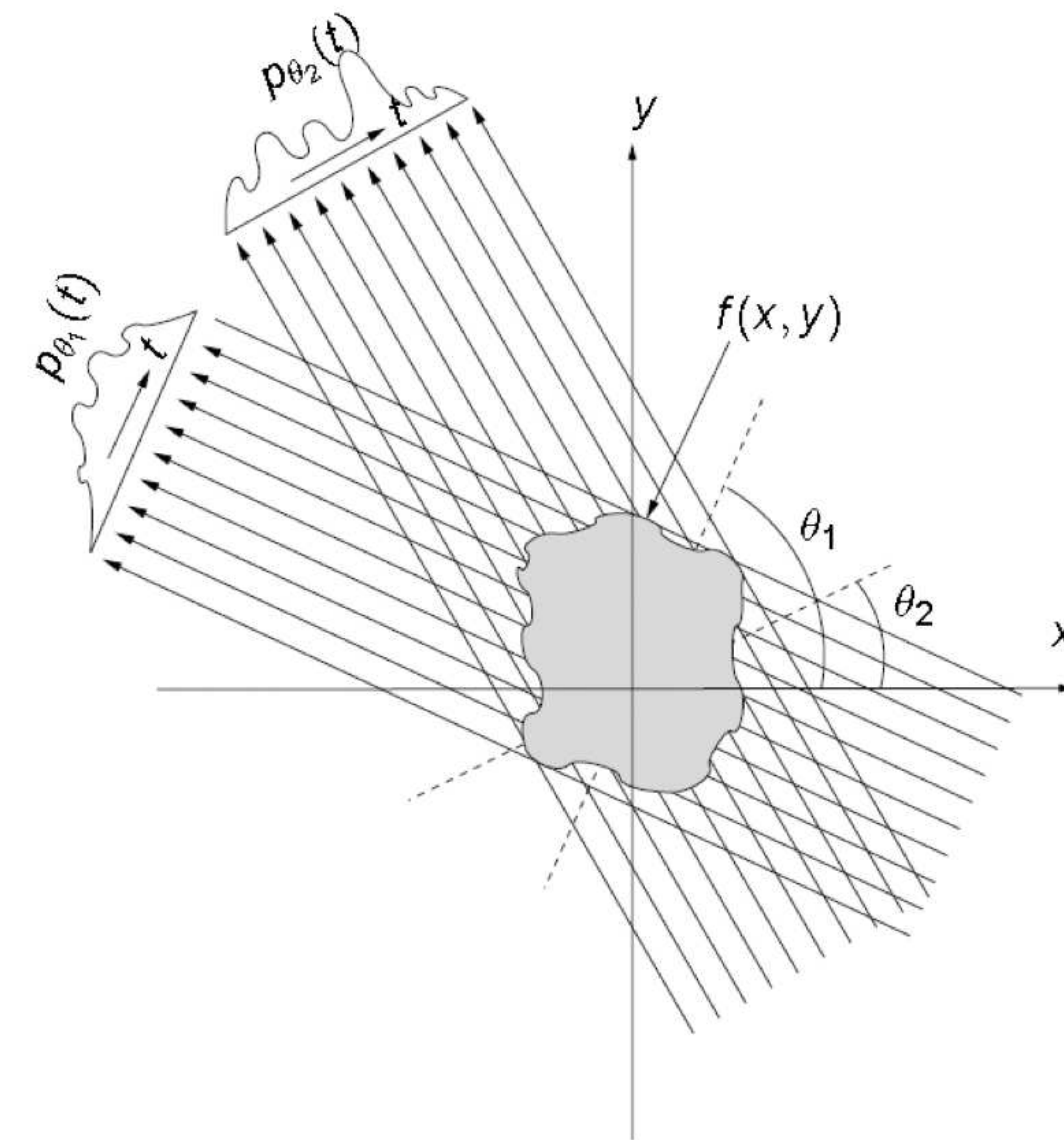


Figure 2: Parallel projection scheme with two different angles  $\theta_1$ ,  $\theta_2$  and the object  $f(x, y)$



# Fan Beam Geometry

- Fan covers the complete object.
- Continuous rotation is possible.

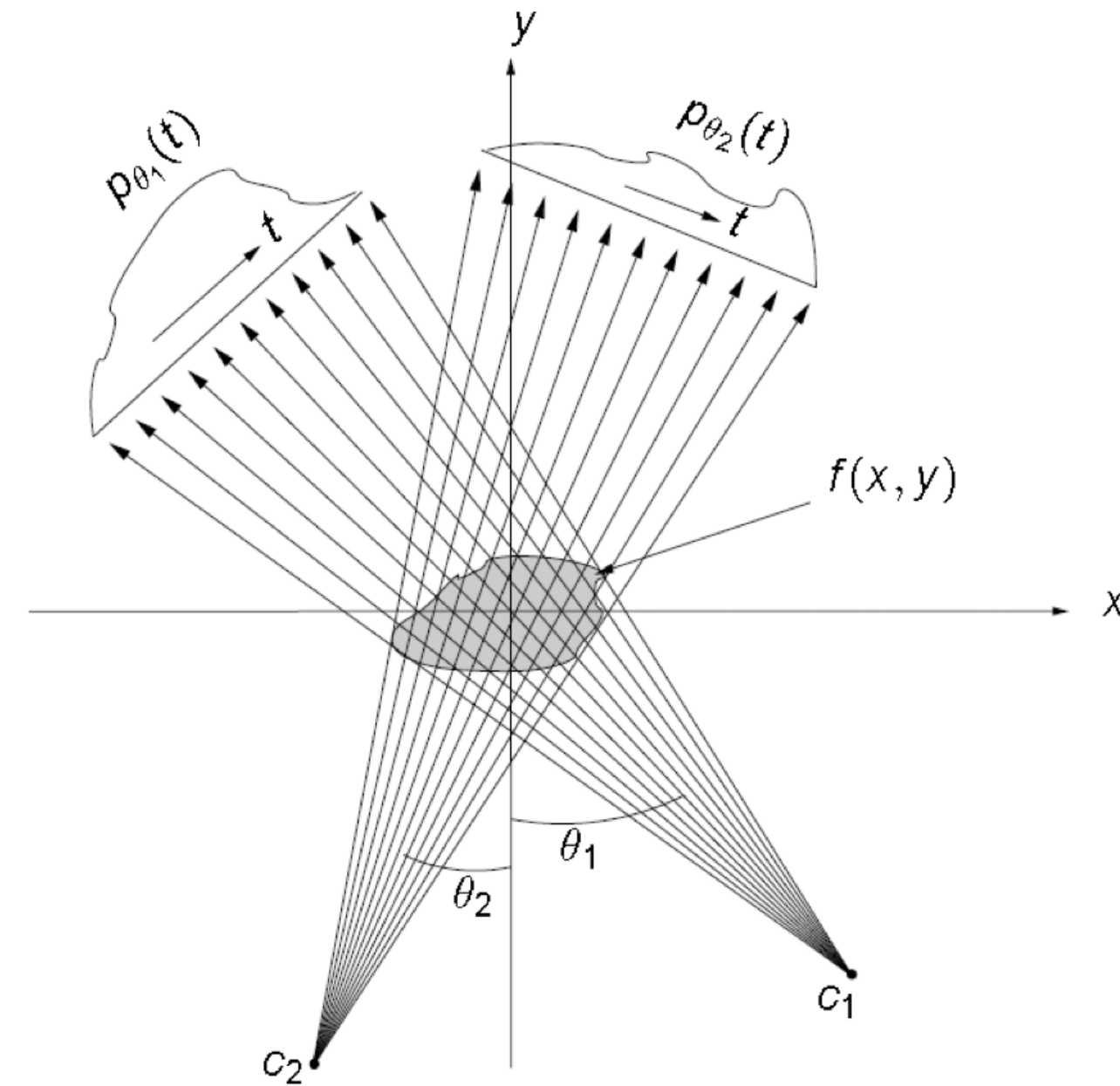


Figure 3: Fan beam projection scheme with two different angles  $\theta_1$ ,  $\theta_2$  and the object  $f(x, y)$

# Cone Beam Geometry

- Cone covers the complete object.
- Continuous rotation is possible.
- This geometry enables fast 3-D acquisition.
- Circular trajectory suffers from incomplete data.

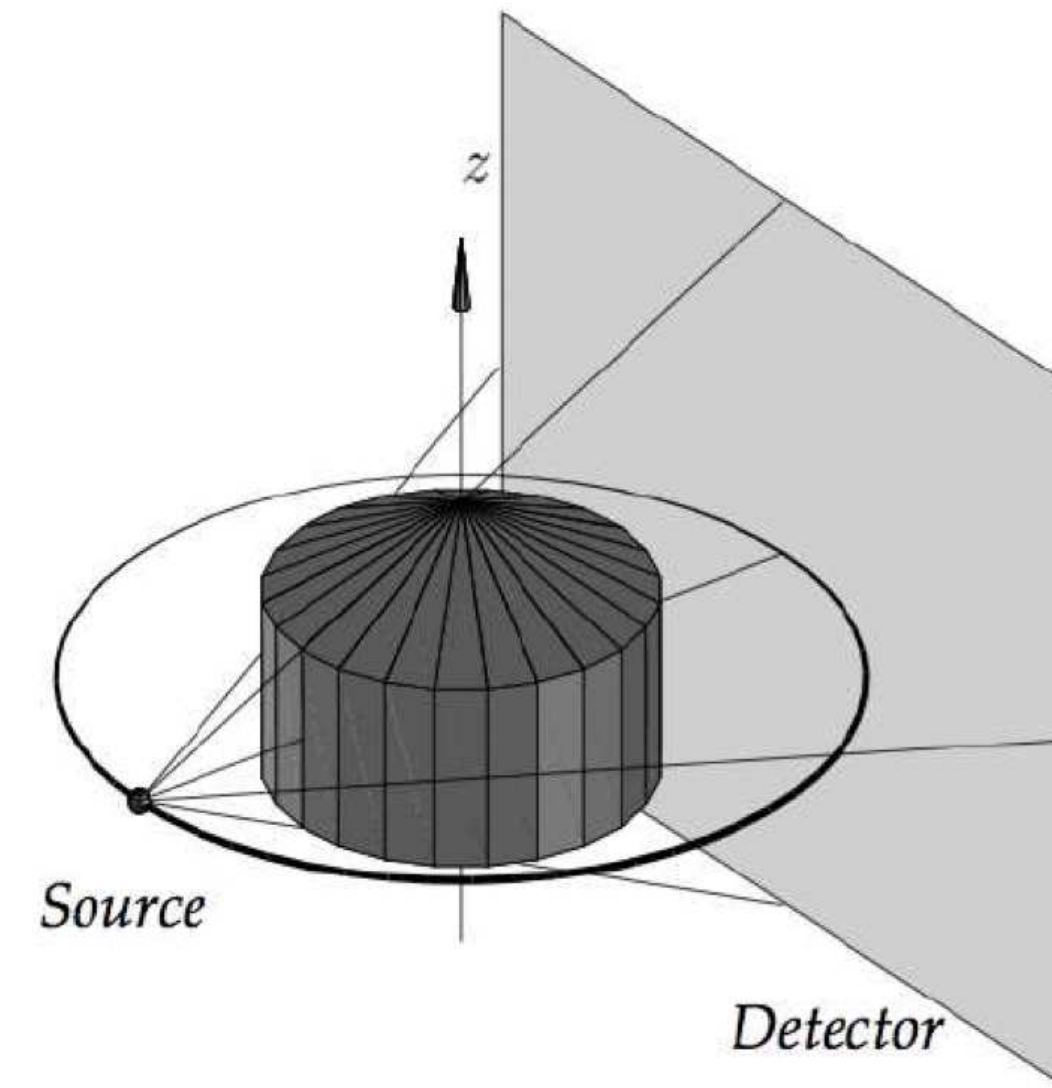


Figure 4: Cone beam scheme

# Helical Scanning

- Helical scanning allows 3-D acquisition with complete data.
- The helix is created by a two-fold motion of a circular gantry rotation and a simultaneous table movement.

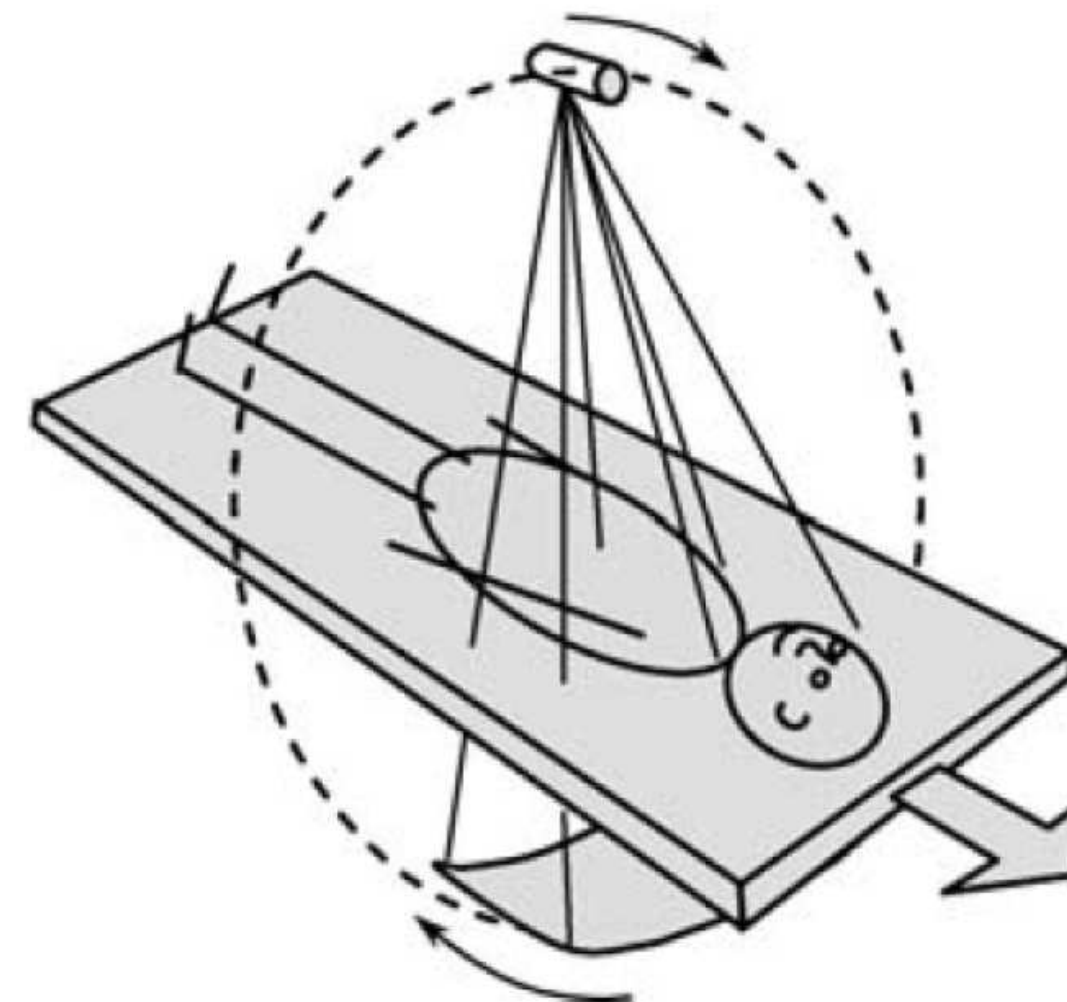


Figure 5: Sketch of an operational helical scan

# Topics

X-ray Computed Tomography

## Summary

Take Home Messages

Further Readings



## Take Home Messages

- This unit was a reprise of the modality “X-ray computed tomography” and the common geometries.
- Every modality has its strengths and its weaknesses → X-ray imaging is the fastest acquisition technology.

## Further Readings

Two reads for more insight into modalities:

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/>

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