Frequency-Combined Extended 3D Reconstruction for Multiple Circular Cone-Beam CT Scans

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Aim

• To provide a reconstruction method for cone-beam sequence scans with reduced noise and reduced cone-beam artifacts
Method A:
Extended Sequence Reconstruction$^1,2$

- Slices farther from the midplane receive less than 360°
- Using also the slices where every voxel is seen at least 180° will increase the z-range.
- Increasing the z-range will also improve the dose usage.

$^2$Grimmer, Berkus, Oelhafen, Kunz, Kachelrieß. IEEE MIC Record M13-207:3759-3763, October 2009
Method B: Combination in Frequency Domain

Rotation

Circle 1

Circle 2

Missing data in frequency space

No missing data in frequency space

Combined image: exact and higher SNR

Circle 1

Circle 2

Weighted average

xsfFDK

- Extended sequence scan frequency-combined Feldkamp (xsfFDK) reconstruction is a combination of
  - Method A and
  - Method B
Materials

• Simulation:
  – 1080 x 1080 detector with 0.5 mm square pixels
  – Cone angle 15°
  – FOM radius is 130 mm

• Varian OBI flat detector CT:
  – 1008 x 752 detector with 0.388 mm square pixels
  – Cone angle 11°
  – FOM radius is 130 mm

• VAMP TomoScope micro-CT:
  – 517 x 476 detector with 0.1 mm square pixels (reduced detector size)
  – Cone angle 6.5°
  – FOM radius is 20 mm
Simulation Study: Increased Overlap
Thorax Coronal

Averaged FDK

Proposed Method

C = 0; W = 300 HU
Simulation: Lower Cone-Beam Artifacts
Thorax sagittal

Averaged FDK

Proposed Method

C = 0; W = 300 HU
Measurement Study: Increased Overlap
Varian OBI Scanner

Averaged FDK

Proposed Method

C = 0; W = 500 HU
Image Noise in the Overlap Region
Varian OBI Scanner
Measurement Study
CTI TomoSope Scanner

Averaged FDK:

Proposed Method:

C = 0; W = 500 HU
Conclusions on xsFDK

• The extended sequence frequency-combined FDK algorithm provides
  – improved image quality in overlap regions
    » reduced cone-beam artifacts
    » reduced noise/dose
  – maintained image quality in non-overlapping regions

• The xsFDK technique can be used to increase the scan length in sequential CT without increasing the dose.
Thank You!

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