CBCT scatter correction by curve fitting technique

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Outline

• Introduction
  – Other methods
• Method
• Results
• Discussion & Conclusions
• References

Introduction

• High scatter with large detector
  – Distortion
  – Contrast loss
• Remove the spatial information from initial signal

Other SC methods

• Hardware
  – Anti-scatter grid
  – Air gap
  – Beam stop array
• Software
  – Primary modulation
  – Monte Carlo

References

Our methods

• A simple method to estimate the scatter

• Validate the our method using Monte Carlo

Purpose

• Estimate the scatter distribution by the information from ROI aside object.

P: primary photon
S: scatter photon
A: attenuated photon
Segmentation

- Fuzzy c-means clustering
- Otsu’s method

Otsu’s method

Fuzzy c-means clustering

- Finding a centroids of dataset
- Fuzz the data and calculate a function close centroids

Dilate

Before

After
**Standard scatter**

- Geant4 application for tomographic emission, GATE

**Digital phantom(1)**

- Material: aluminum (rectangular)
- 50 keV mono-energy
- Only one projection

**Digital phantom(2)**

- Material: water phantom inserted two cylinders of iron
- 80 keV mono-energy

Contrast (C) = \( |\bar{u}_{\text{iron}} - \bar{u}_{\text{water}}| \)

\[ t_{\text{cup}} = 100(\bar{u}_{\text{center}} - \bar{u}_{\text{edge}})/\bar{u}_{\text{edge}} \]
• Complex object will affect the real scatter!

Result

Before correction
• ROIs: 20*20
• Contrast: 11% → 17%
• Cupping artifact reduction: 88% → 67%

After correction

Discussion
• Noise wouldn’t affect fitting processing
• Fit well in simple object

Conclusions
• Independent on
  – Source
  – OID
• Improve contrast: 11% → 17%
• Reduce cupping artifact: 88% → 67%
References


• Thank you for attention!

• Using poly-energy to simulate the system matching real situation
• Finding a fitting model
• Downsample to suppress noise
Fuzzy c-means clustering

\[ J_m = \sum_{i=1}^{c} \sum_{k=1}^{N} u_{ik}^m ||x_i - v_k||^2 \]

\[ U \in \left\{ u_{ik} \in [0,1] \mid \sum_{i=1}^{c} u_{ik} = 1, \ \forall k \ \text{and} \right\} \]

\[ 0 < \sum_{k=1}^{N} u_{ik} < N, \ \forall i \} \]