Characterizing the Imatron C-300 Medical CT scanner and effort to develop matched FBP

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Objectives

• The goals of this project were
  1. To characterize the Imatron C300:
     • Understand geometry
     • Understand file formats
     • Understand data readout
  2. To develop open source offline code matching as closely as possible the output of Imatron’s onboard gridding-based algorithm.
  3. More broadly, to demonstrate the feasibility and benefit of having a set of open/medical data together with a validated system model in the "public domain" that can be used for experimentation and collaboration.
Results

Imatron xrec reconstruction

UofC recon starting from “clipped” xrec sino

Difference

W: (-1000,3095)

Average difference = 1.11 H.U
Max difference = 126.92 H.U

Take away: All researchers have been able to reconstruct data using their own algorithms based on characterization provided by the University of Chicago.
Introduction to the team

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Imatron C300 System

- This is an electron beam scanner that uses a fourth generation geometry in which detectors are fixed and subtend a large arc around the patient and electron source is scanned along large arc.
- This differs from clinical scanners based on third generation geometry where both source and detectors rotate. Imatron is faster (~50 msec) and good for cardiac.
Geometry – Single Slice Mode

- Focal length = 675.0 mm or 675.5 mm
- Number of true projection views = 864
- Number of effective projection views = 888 (augmented during corner filling)
- Angular range of 888 views is 222, which is Pi + fan angle
- Angular increment 0.25 degrees
- Fan angle = 41.26696016°
- Angle between fan channels = 0.0478180°
- Number of fan channels = 864
- Field of view at the isocenter = 475.0 mm
Xrec data processing flow chart.

- We characterized the various outputs and made recommendations about which sinograms researchers should consider working with. Only 1 or 2 were used.
Extracting and Reading Sinograms from xrec.exe

- **LINEARIZED**
  - -sino lin; Floating point data 864x888

- **INTERPOLATED**
  - -sino int; Floating point data 864x888

- **CORNER FILLED**
  - -sino cfl; Floating point data 864x888

- **REBINNED**
  - -sp; Floating point data 1024x720

Arrow denotes most commonly used sinograms.
Basics of Imatron recon

• Imatron
  – Parallel rebinning from fan sinogram
    • One-dimensional cubic interpolation in columns
    • Apply Parker weights
    • One-Dimension cubic interpolation in rows
  – Gridding reconstruction

• Our efforts:
  – First FBP from parallel
  – Then FFBP from fan
  – Then gridding reconstruction from rebinned projections
Results: direct Fourier/gridding

Imatron reconstruction

UofC reconstruction

Difference

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Strengths and weaknesses

• Overall we provided a very thorough description of the Imatron geometry and data format that was valuable to the other researchers involved.
• We came very close to exactly matching the Imatron reconstruction performance but small differences remained likely due to differences in interpolation kernels, numerical implementations, etc.
Recommendations for future work

• Develop more offline code to replicate earlier takeoff points of xrec.

• Develop more thorough physical models of scanner degradations (scatter, afterglow, crosstalk) to allow for more advanced model-based corrections and methods.

FTP site:
sftp://craw404@eng-filetransfer.bu.edu/eng_research_TO3/PatrickDocsandSinos/MatlabCode

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