Title for the talk

Author List

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Basics

- Radon transform : Real $\rightleftarrows$ Sinogram space.
- $\mathrm{Rf}(\tau,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \mathrm{f(x,y)}\delta(\tau - \mathrm{xcos}(\theta) - \mathrm{ysin}(\theta))\mathrm{dxdy}$

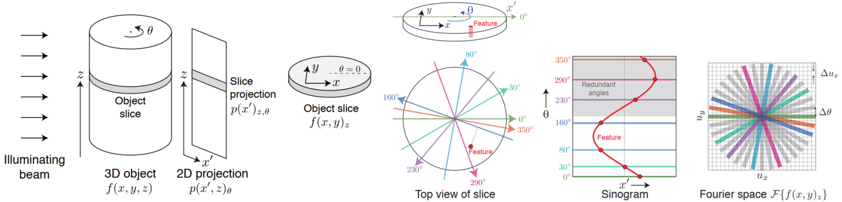

Figure: Spinning the object to obatin ”sinograms”, reconstruct each slice independently[2]

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[1] ?

[2] ?

Center of rotation drifts

- $P_\theta = x^*_\theta(1 - \cos(\theta) + y^*_\theta \sin(\theta))$
- $Rf(\tau, \theta, 0, 0) =$
  $Rf(\tau - P_\theta, \theta, x^*_\theta, y^*_\theta)$
- Translation of sinogram by P_θ achieved by convolution with gaussian.
- Recover P_θ to obtain accurate reconstruction!

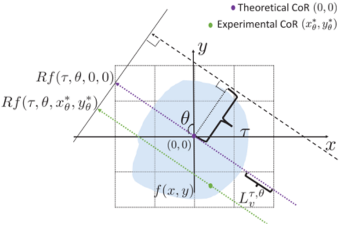

Figure: Center of rotaion drift causes us to measure the shifted sinograms!

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Optimzation formulation

Discretize & Vectorize

- $\mathcal{W}$: object vector
- $\mathcal{L}$: discretized radon transform
- $\mathcal{D}$: measure sinogram

Least squares cost function

- To recover both shifts and object : $\min_{\mathcal{W}\geq 0, \mathrm{P}_\theta} \phi(\mathcal{W}, \mathrm{P}_\theta) = \frac{1}{2}||\mathcal{L}\mathcal{W} - \mathrm{g}(\mathcal{D}, \mathrm{P}_\theta)||$
- First order derivaties analytically computable : $\nabla\phi(\mathcal{W}, \mathrm{P}_\theta) = [\mathcal{L}^{\mathrm{T}}, \nabla_{\mathrm{P}_\theta}\phi(\mathcal{W}, \mathrm{P}_\theta)](\mathcal{L}\mathcal{W} - \mathrm{g}(\mathcal{D}, \mathrm{P}_\theta))$

Implementation

- Implemented in C/C++ using :
  - PETSc (which handles the optimization routines, data management and parallel I/O)
  - Boost (which handles geometry routines)
  - FFTW (for position correction cost function evaluation).

Joint

- Combine shifts and sample into one vector and optimize for both together.

Alternating

- Alternate between optimizing with respect to sample and with respect to shifts.

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Accuracy

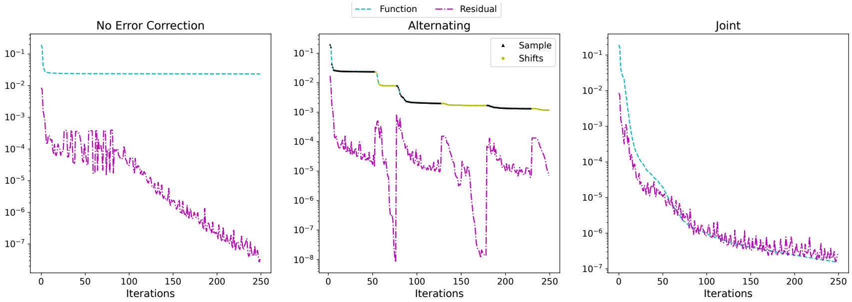

Figure: Objective function and gradient norm as a function of iteration number. Dimensions of unknowns : 50 + 256x256 and size of experimental data : 256x50

Scaling

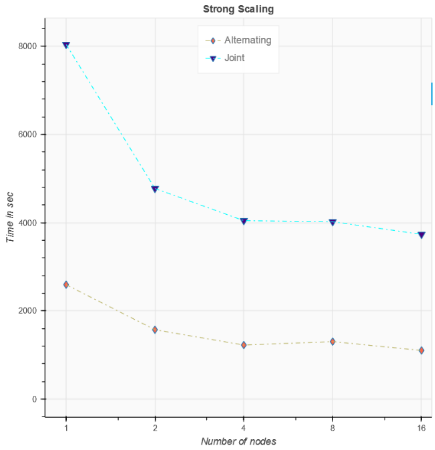

Figure: Strong scaling plots for alternating and joint reconstruction algorithms.

Outline

Next Steps

- Invert 3D tomography data by replicating the 2D solve on sub-communicators.
- Port application to GPU.

graphics/closing.png

References I