



Projected Gradient Method for Regularized Cryo-Electron Tomographic Reconstruction

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Introduction

- Weighted Back Projection (WBP) and Algebraic Reconstruction Technique (ART) are the most common methods for 2D/3D tomographic reconstruction in Cryo-Electron Tomography (Cryo-ET).
- Developing a reconstruction technique that incorporates the sparsely sampled data, the noise level, and that preserves the structural edges while pushing the limits of resolution further, is highly desirable for the Cryo-ET community [1].

Contribution:

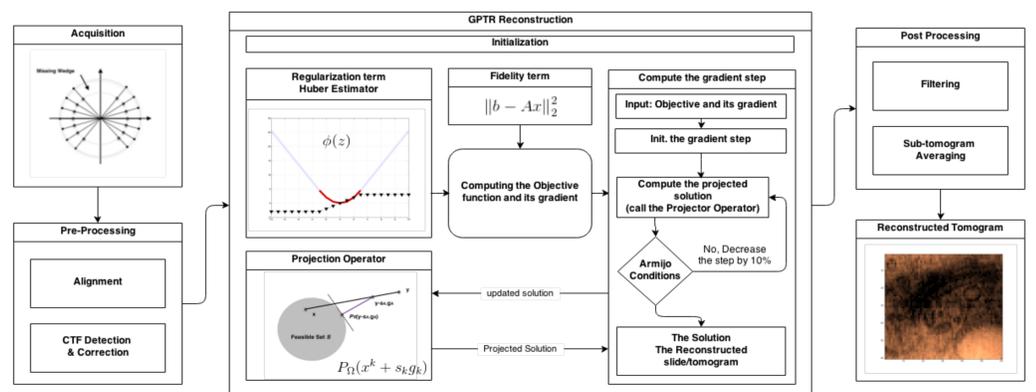
We develop the Gradient Projection for Cryo-Electron Tomographic Reconstruction (GPTR), Here, we propose a new regularized reconstruction technique based on projected gradient algorithm

Methodology & GPTR Algorithm:

- Given a 2D aligned projection stack from the Electron Microscopy instrument (typically 50-60 projections with resolution 2Kx2K).
- Slice-Wise reconstruction: collecting the corresponding slices from the projections to build up the sinogram, then stack them together in one vector (b).
- Based on the Electron Tomography configuration, the system matrix (A) is built by [2] using Discrete Radon Transform.
- Now, we can formulate the reconstruction problem as an Optimization problem trying to minimize the objective function as follows:

$$x_{opt} = \arg \min_{x \in \Omega} \|b - Ax\|_2^2 + \beta \phi(x)$$

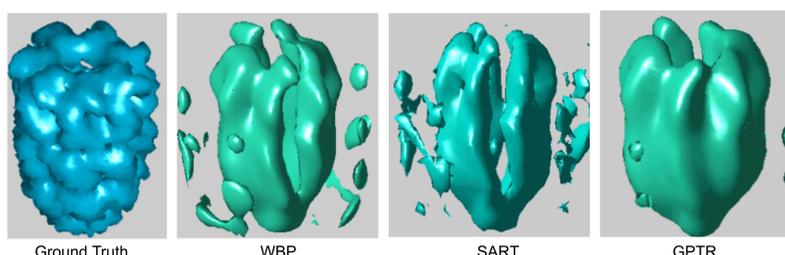
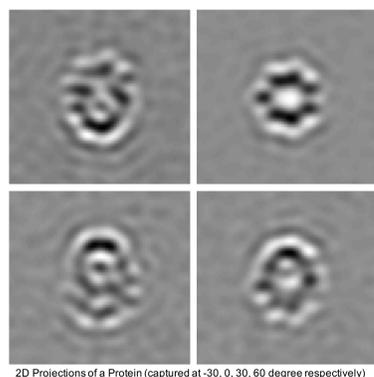
- The Huber function is used as a regularizer term in the objective function for the following goals:
 - Keep the Objective function convex and smooth.
 - Push the solution to Sparsity
- Based on the Gradient Projection Algorithm [3], GPTR is developed to solve the problem



Experiments & Results:

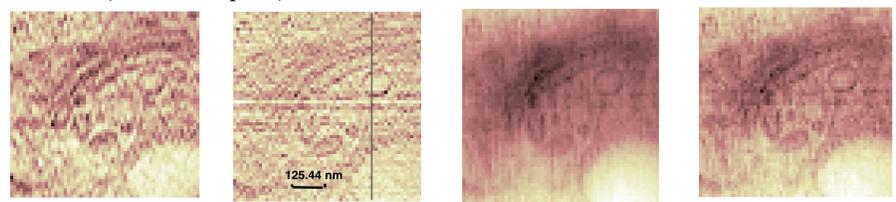
Experiments and Results:

- **Synthetic data from PDB database (GroEL)**
 - 40 Projections
 - Tilt angles = -60° to 60° (3° increment)
 - SNR=1
 - 64x64 (pixel size=12.6nm)

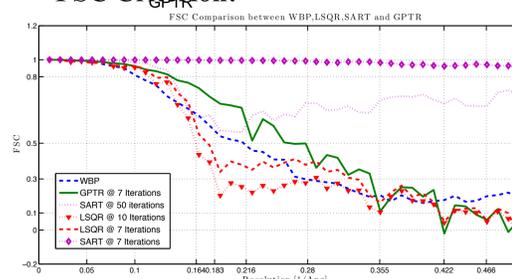


Real data[4]:

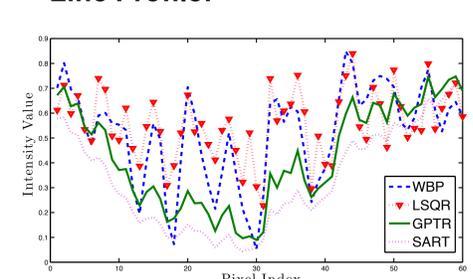
- 58 Projections, tilt angles = -58° to 58° (2° increment)
- SNR=0.1
- 1Kx1K (down-sampled)



FSC Criterion:



Line Profile:



References:

- [1] Diebolder, C.A. et al.: Pushing the resolution limits in cryo electron tomography of biological structures. J. Microsc. 248, 1, 1–5 (2012).
- [2] Hansen, P.C., Saxild-Hansen, M.: AIR Tools—A MATLAB package of algebraic iterative reconstruction methods. J. Comput. Appl. Math. 236, 8, 216–2178 (2012).
- [3] Figueiredo, M.A.T. et al.: Gradient Projection for Sparse Reconstruction: Application to Compressed Sensing and Other Inverse Problems. IEEE J. Sel. Top. Signal Process. 1, 4, 586–597 (2007)
- [4] Dumoux, M. et al.: Chlamydiae assemble a pathogen synapse to hijack the host endoplasmic reticulum. Traffic. 13, 12, 1612–1627 (2012)