Multi-scale Three-Dimensional Reconstruction of Ptychographic X-Ray Tomography Data

Slyamov, Azat M.; Ramos, Tiago; Andreasen, Jens W.

Publication date: 2019

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Multi-Scale Three-Dimensional Reconstruction of Ptychographic X-Ray Tomography Data

Azat M. Slyamov, Tiago Ramos, Jens W. Andreasen

Technical University of Denmark, Department of Energy Conversion and Storage, 4000 Roskilde, Denmark

**Introduction**

Ability to image volumetric structure of nano/microscale systems in material science brings a better understanding of the structure-function correlations that can significantly increase their performance in applied fields. Direct 3D reconstruction from coherent diffraction X-ray imaging (CDI) data requires large computational recourses. Therefore, we present here a multi-scale approach for reducing convergence time by fast reconstruction of low-resolution image and its further application as an input guess for high-resolution reconstruction.

**Coherent X-ray diffraction imaging**

In CDI experiment an incident wave interacts with a sample experiencing refraction and attenuation and propagates into a far-field detector that measures its intensity given by

\[ I \equiv |\mathcal{F}\left\{ P \ast \exp\left[i\kappa n\right]\right\}|^2 \]

where \( P \) is illumination function, \( n \) is complex refractive index of the sample (object function) and \( \mathcal{F} \) is Fourier transformation.

**Phase-retrieval algorithm**

Reconstruction of the sample can be formulated as a least-squares optimization problem solved by iterative minimization of the difference between measured and approximated diffraction intensities:

\[
\min_x \sum_{m,j} \left( I_m^x(x) - I_m^\text{meas} \right)^2
\]

Complex valued object function and squared modulus operation in the expression for intensity make the problem ill-posed and non-linear. Here, we use Levenberg-Marquardt algorithm (LMA) in combination with conjugate gradient method (CGM) to find the optimal solution.

**Acknowledgments**

This PhD project is part of the Marie Skłodowska-Curie Innovative Training Network MUMMERING (Multiscale, Multimodal, Multidimensional imaging for EngineeRING), funded through the EU research programme Horizon 2020.

**Future work**

Here, we present an extension of the direct 3D ptychographic reconstruction using multiscale approach. The next step towards decreasing computational costs of the algorithm is to solve the problem of scanning path optimization with instrumental constraints. The final goal is to implement developed algorithm to a real data.

**References**


