

Algebraic Reconstruction of Ultrafast Tomography Images at the Large Scale Data Facility

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- Synchrotron light source at KIT: storage ring, beamline labs
- **Topo-Tomo** beamline: parallel X-ray beam, tomography experiment
- Studying **moving biological samples** in 3D: beetles, frog embryos



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Minimizing the effects of movements on

- reconstruction accuracy
- Lower radiation dose \rightarrow longer lifetime for scientific studying

Motivation of sparse reconstruction

Ultrafast tomography system: continuous

→ 100-400 projections in [0°-180°] : insufficient data for exact image reconstruction



rotation, high speed



Reconstruction

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- Standard reconstruction method: filtered-back projection (FBP)
 - \rightarrow artifacts
- Better reconstruction algorithm needed
 - Sparse reconstruction technique based on Total Variation (TV): accurate signal restoration of incomplete data



CS-ART (Compressive Sampling-based Algebraic Reconstruction Technique)

- Precise forward model: geometry of detectors
 - X-ray line: width, distance
 - Equations system: p=As
 - Precise reconstruction
- TVAL3*
 - Solver of linear inverse problem with TV minimization
 - Promising image reconstruction, fast convergence rate



*TVAL3

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C. Li, W. Yin and Y. Zhang, "User's guide for TVAL3: TV minimization by augmented lagrangian and alternating direction algorithms", 2010.

Reconstruction images



CS-ART algorithm produces high quality images using only a few projections.



(reference)

- Data reduction
- High quality image (image segmentation)
- → Parallelization required
- Computing expensive
- Thousand parallel slices: **10 min** (standard), **tens of hours** (CS-ART)

LSDF & Parallel computing



- LSDF: Large Scale Data Facility at KIT for data intensive scientific experiments
 - **Storage** facility
 - \rightarrow Data storage, management and access
 - **Computing cluster** with 58 nodes
 - \rightarrow Data computing and analysis in parallel





- Data parallel computing
 - Each slice: MATLAB software, independently
 - 1024 slices \rightarrow mapping task \rightarrow Hadoop cluster (computer nodes)

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Parallel computing performance







Conclusions

- CS-ART algorithm shows high potential to reconstruct better images for reduced data.
- The promising reconstruction result and high computing performance at LSDF greatly support the construction of the ultrafast tomography system at ANKA.
- Workflow of LSDF will enhance the data storage, management and automatic data intensive computing for ANKA.
- Workflow of LSDF is not limited to ANKA. It also supports other institutes involving data intensive computing (micro-tomography and other tomography experiments).