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Fast Distributed Image Reconstruction using CUDA/MPI

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In this work, we present a fast implementation for analytical image reconstruction from projections, using the so-called "backprojection-slice theorem" (BST). BST has the ability to reproduce reliable image reconstructions in a reasonable amount of time, before taking further decisions. The BST is easy to implement and can be used to take fast decisions about the quality of the measurement, i.e., sample environment, beam-line conditions, among others. A synchrotron facility able to measure a three-dimensional dataset Y within few seconds, needs a fast reconstruction algorithm able to provide a fast "preview" of the tomography within the same amount of time. If the experimental conditions are not satisfactory, the quality of the reconstruction will decrease, and the researcher can decide either to make another scan, or to process later the data using advanced reconstruction algorithms or even high quality segmentation methods. The difficulty here is that inversion algorithms depends on the backprojection operator, which is defined as an average through all the x-rays passing at a given pixel. Backprojection presents a high computational complexity of $O(N^3)$ for an image of N^2 pixels. The brute-force approach to compute the backprojection operator can be made extremely slow, even using a GPU implementation. Sophisticated ray-tracing strategies can also be used to make the running time faster and others analytical strategies reduce the backprojection complexity to $O(N^2 \log N)$. The BST approach have the same low complexity of $O(N^2 \log N)$ although easier to implement than his competitors, producing less numerical artifacts and following a more traditional "gridding strategy".

Desired length

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