

Cone-beam CT (CBCT) has been widely used in image guided radiation therapy (IGRT) to acquire updated volumetric anatomical information before treatment fractions for accurate patient alignment purpose. However, the excessive x-ray imaging doses (a few cGy per scan) delivered to patients from serial CBCT scans raise a clinical concern in most IGRT procedures. This fact has greatly limited exploitation of IGRT's maximal potential. The imaging dose can be effectively reduced by reducing the number of x-ray projections and/or lowering mAs levels in a CBCT scan. The image quality reconstructed from conventional FDK-type algorithms, however, will be highly degraded. Recently, total variation (TV) method has demonstrated its ability to reconstruct CBCT images from a few number of noisy x-ray projections. Nonetheless, such a method can hardly be applied in real clinical environments due to its long computational time (a few hours). It is highly desirable to develop a fast reconstruction scheme to obtain high quality CBCT images from undersampled and noisy projection data so as to lower the imaging dose.

Utilizing GPU to speed up the computationally intensive tasks in CBCT reconstruction problems has drawn a lot of attention recently. In this talk, GPU-based CBCT reconstruction algorithms will be reviewed, with an emphasis on an iterative CBCT reconstruction algorithm via TV regularization. We have recently developed a GPU-friendly version of the forward-backward splitting algorithm to solve the TV-based reconstruction problem. Multi-grid technique is also employed. It is found that 40 x-ray projections are sufficient to reconstruct CBCT images with satisfactory quality for IGRT patient alignment purpose. Phantom studies indicate that CBCT images can be successfully reconstructed with our algorithm under as low as 0.1 mAs/projection level. Comparing with currently widely used full-fan head-and-neck scanning protocol of about 360 projections with 0.4 mAs/projection, it is estimated that an overall 36 times dose reduction has been achieved. Moreover, the reconstruction time is about 130 sec on an NVIDIA Tesla C1060 GPU card, which is estimated ~100 times faster than similar iterative reconstruction approaches. The high computational efficiency and satisfactory image quality make the iterative low dose CBCT reconstruction approach feasible in real clinical environments.

Learning Objectives:

1. Understand basic concepts of GPU-based CBCT reconstruction.
2. Understand main challenges in GPU-based iterative CBCT reconstruction approach and how an iterative CBCT reconstruction problem is solved on GPU.

Conflict of Interest:

The research presented here is partially supported by NVIDIA.