# Advanced CT Image Reconstruction Algorithms via Compressed Sensing

The key components of an x-ray computed tomography system are the source, detector, and image reconstruction algorithms. The introduction of multi-row detectors has enabled larger scanning coverage, higher spatial and faster complete organ scanning in the general purpose CT scanners. These improvements have enabled a variety of advanced clinical applications. The introduction of flat-panel detectors has enabled dedicated cone-beam CT in breast imaging, image-guided interventions, and image-guided radiation therapy. There is a constant interplay between the development of new and improved CT systems and advanced CT image reconstruction algorithms. New CT systems require advanced image reconstruction algorithms, and breakthroughs in image reconstruction algorithms may also enable future innovations in the future design of CT systems.

The Shannon sampling theory is the foundation of conventional linear image reconstruction algorithms such as the Fourier transform and filtered backprojection methods. In these conventional image reconstruction frameworks, the violation of the Shannon sampling criterion often results in aliasing artifacts such as streaks in the reconstructed images. Recently, a new sampling theory, i.e., compressive sampling, has been formulated. It has been proven that accurate image reconstruction is possible using highly undersampled data sets provided that a nonlinear iterative image reconstruction method is utilized. This nonlinear iterative image reconstruction method is widely referred to as compressed sensing (CS). Based on the CS theory, some other generalized CS image reconstruction algorithms such as prior image constrained compressed sensing (PICCS) were recently proposed to reconstruct CT images.

In this talk, we will discuss the potential impact of CS-based CT image reconstruction algorithms and their impact on current and future CT development.

Educational objectives:

1. Understand violation of sampling criterion may cause streaking artifacts in conventional linear image reconstruction algorithm;
2. Understand Compressed Sensing based image reconstruction algorithms can generate streak-free image using a highly undersampled data set;
3. Understand the potential benefit of PICCS algorithm in radiation dose reduction and improve temporal resolution using a slow gantry.