

Current image reconstruction methods used in tomographic imaging modalities such as CT were developed under the assumption that a complete and consistent dataset was acquired during data acquisition. In practice, however, the acquired data are often not consistent. As a result, the application of a well-developed image reconstruction algorithm to an inconsistent dataset generates artifacts in the reconstructed images. Conflicts between classical image reconstruction theory and the physics involved in the data acquisition procedure motivate us to incorporate the data consistency information into image reconstruction. In the proposed data consistency driven image reconstruction framework, a data inconsistency metric was introduced to classify an acquired dataset into different consistency classes. A conventional single class reconstruction strategy was generalized to reconstruct multiple consistency classes jointly in a matrix completion form using the proposed Simultaneous Multiple Artifacts Reduction in Tomographic RECONstruction algorithm. The proposed framework was applied to improve three-dimensional cone-beam CT (CBCT) image quality, generate time-resolved CBCT angiography from a single short-scan data acquisition, and improve the temporal resolution of CBCT by a factor of more than 30-times, so that an average of 7.5 frames per second temporal resolution can be achieved in a multi-sweep data acquisition protocol. These novel imaging techniques will enable physicians to improve their toolbox for better clinical care.