Cone-beam reconstruction algorithms development and validation for C-arm cone-beam CT

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CT systems with multi-row detectors or flat-panel imagers provide larger volume coverage in one single gantry rotation and have been widely used for both diagnostic radiology and image-guided therapeutic procedures. However, the cone-beam nature of the data acquisition with large area detectors poses challenges for image reconstruction. The first challenge is that mathematically exact image reconstruction algorithms have to be developed for each individual cone-beam scan configuration. No general analytical algorithm can be applied to any CT scanning geometry. The second challenge is that new data acquisition geometries must be developed since a single circle/arc scan can not enable artifact free image reconstruction from cone-beam projection data. In this thesis, we present several novel cone-beam image reconstruction frameworks. These frameworks are used to derive mathematically exact image reconstruction algorithms for each different source trajectory. One example of the complete source trajectory which consists of two concentric arcs (CC-geometry) can be implemented using C-arm based cone-beam CT, which can provide 3-dimensional map for image guided interventions. We developed cone-beam image reconstruction algorithms for the C-arm CT using CC-geometry. Experimental data from physical phantoms and an animal model were used to validate these algorithms.