AbstractID: 6748 Title: Scatter correction for flat detector cone-beam CT based on simulated sphere models

Purpose: Uncompensated scattered radiation is one of the major image quality deteriorating factors in flat detector cone-beam CT. Purpose of this work is to develop a fast, practical, and accurate method for a posteriori correction of X-ray scatter.
Method and Materials: Scatter estimation and correction is carried out using a novel approach based on locally approximating the imaged object by water sphere models. In each projection, the scatter contribution of each ray from the source to the individual detector pixels is derived from a pre-calculated database of pencil-beam Monte-Carlo simulations. The different sphere configurations have the advantage over related existing methods that they allow to accurately reproduce scatter contributions of individual rays regardless of the position of object penetration. Systematic evaluation was carried out by constructing an extensive database of Monte-Carlo patient simulations, by performing scatter measurements of 15 phantoms on a bench-top X-ray system, and based on rotational C-arm acquisitions from clinical interventional procedures.
Results: The novel method was found to produce far superior results than related state-of-the-art approaches. Based on simulated projections of 13 CT data sets of different body regions (head, thorax, abdomen, liver, pelvis), an average reduction of scatter-caused inhomogeneities from 117 HU to 11 HU per-voxel deviation from the ground truth was achieved. For individual data sets, the average level of the estimated scatter deviated from the respective optimum by only 5% as compared to a minimum of 14% for tested state-of-the-art approaches. Experimental evaluation and application to clinical data confirmed robustness and efficient reduction of cupping and streak artifacts in reconstructed images.
Conclusion: A practical software-based method was developed allowing to accurately estimate scatter contributions in X-ray projections. Utilization of this method efficiently reduces scatter-caused artifacts, and thus substantially improves image quality in flat detector cone-beam CT.