AbstractID: 6751 Title: An Adaptive Simultaneous Algebraic Reconstruction Technique

Purpose:
To improve the computational efficiency of Algebraic Reconstruction Technique (ART), and suppress the "stripping" artifacts due to ART like ray-by-ray update, especially in cone-beam reconstruction.

Method and Materials:
Inspired by Adaptive ART (AART) and Simultaneous ART (SART), a new ART, the Adaptive Simultaneous ART (ASART), which combines multi-level scheme (MLS) data-access scheme, data-driven contribution weighting, and SART like updating, is proposed.

When the CT system is modeled as $\mathbf{Wv} = \mathbf{p}$, ASART can be mathematically expressed as:

$$v_j^{(k+1)} = v_j^{(k)} + \lambda \frac{\sum_{i \in I_\varphi} (p_i - \sum_{n=1}^{N} w_{in} v_n^{(k)}) w_{ij}}{\sum_{i \in I_\varphi} (\sum_{n=1}^{N} w_{in} v_n^{(k)}) w_{ij}} v_j^{(k)} = v_j^{(k)} \left\{ (1-\lambda) + \lambda \frac{\sum_{i \in I_\varphi} p_i w_{ij}}{\sum_{i \in I_\varphi} (\sum_{n=1}^{N} w_{in} v_n^{(k)}) w_{ij}} \right\},$$

where λ is the relaxation factor that is typically chosen within the interval $(0.0, 1.0]$ and the initial value $v_j^{(0)}$ are uniformly set to be a nonzero value. This method combines the advantages of SART and AART: the feature of SART, simultaneous correction image update in each view, is introduced into AART. In ASART, the reconstructed object is updated view-by-view, rather than ray-by-ray, and all views are accessed according to MLS. In general, the computation burden for ASART is less than that of SART.

Results:
For quality evaluation, we adopt a 3D extension of the Shepp-Logan phantom, in which the least value variance is only 0.5% of the maximal value of the model, in our experiments. It is observed that ASART always achieves higher correlation coefficient (CC) than MLS-SART does. Actually, 1-iteration ASART produces much higher CC than 10-iteration MLS-SART does in our experiments. We have also applied the proposed approach on real dataset reconstruction. Fine image details are fairly visible in the slices obtained by our approach when only 96 limited numbers of projections are used.

Conclusion:
A new image reconstruction technique inspired by AART and SART is proposed in this work. Although the convergence has not been proved mathematically, this approach always performs well in our experiments. Both quantitative and visual analyses have shown that promising computational efficiency and better reconstructed image have been achieved.