

Purpose:

To evaluate the performance of the first commercial amplitude-binning algorithm for 4DCT reconstruction, to compare its reconstructed image quality to that of the phase-binning algorithm, and to investigate possible clinical effects from changing algorithms.

Methods:

A department customized 4DCT motion phantom was utilized to evaluate the geometry accuracy (correct phase sequencing and motion) of the amplitude-binning algorithm. 64 4DCT patient cases, in which 60(4) cases were acquired with 4D chest (abdomen) protocol, were collected and evaluated on the respiratory motion artifact severity. The MIP images generated from both algorithms for 10 SBRT cases were further evaluated by two radiation oncologists regarding the tumor sizes and locations.

Results:

The phantom experiments illustrated that, as expected, maximum inhalation occurred between 90%-10% phases, while maximum exhalation occurred between 40%-60% phases. The amplitude-binning algorithm provides reasonable phase sequencing and motion within the 4D images.

The amplitude-binning algorithm yielded fewer respiratory motion artifacts on 24/64 cases (37.5%), comparable artifacts to the phase-binning algorithm on 35/64 cases (54.7%), and slightly greater artifacts on 5/64 cases (7.8%).

The 10 SBRT cases indicated that the reconstructed tumor sizes and locations were comparable on 9 MIP image pairs generated from amplitude-binning and phase-binning, respectively. However, amplitude-binning yielded smaller tumor size on one case probably due to the very shallow respiratory amplitude occurring over several breathing cycles.

Conclusions:

Overall, amplitude-binning algorithm yielded fewer or equivalent artifacts on 92.2% of cases (59/64 cases), and no dramatic difference on reconstructed tumor sizes and locations from the MIP images based on amplitude and phase binning algorithms. We suggest utilizing the amplitude-binning 4DCT images for clinical practice, especially for SBRT cases. If very shallow respiratory waves or severe motion artifacts were found on specific cases, physicists should work with the physicians to provide the best achievable 4D images.