AbstractID: 3084 Title: A Comparison of Amplitude- and Phase-Based 4D CT

Purpose:
Four-dimensional (4D) CT depends on accurate correlation between temporally acquired CT slices and the patient's respiratory cycle. One approach is to record the position of an external marker placed on the abdomen or chest during the scan, and retrospectively match the CT data with the phase of the marker motion. While very effective for regular breathing patterns, the phase-based approach can lead to significant mismatch between adjacent image segments when the respiratory motion exhibits irregularities. We propose a method of extracting amplitude-based 4D CT from cine-acquired CT data sets, and compare the amplitude-based 4D CT with the phase-based 4D CT for both phantom and patient data.

Method and Materials:
CT data sets were acquired in cine mode on the GE Discovery ST, and motion of an infrared reflecting block was recorded using Varian's Real-time Position Management (RPM) camera. Rather than use the phase-based calculations of the RPM system, we replaced the phase field with pseudo-amplitude values spanning the full respiratory cycle (i.e., differentiating inspiration from expiration). The modified respiratory trace file was then sent, along with the cine CT data, to the GE Advantage Workstation for processing. The method was applied to a thoracic phantom moving irregularly in the longitudinal direction, and to an abdominal 4D scan of a lung cancer patient.

Results:
For both phantom and patient data, the phase-based 4D CT images showed boundary mismatches of up to 1 cm between couch positions. The mismatch on the amplitude-based sets, however, was less than 2 mm throughout the field of view.

Conclusion:
Phase-based 4D CT can lead to mismatched slices when the respiratory cycle involves irregularities. In such situations, by replacing phase with a modified definition of amplitude that distinguishes inspiration from expiration, a substantially improved 4D CT image can be generated.