AbstractID: 12958 Title: Image-based material decomposition with energy resolving computed tomography

Purpose: To decompose four materials in the image domain using an energy resolving detector.
Methods and Materials: A post-mortem breast specimen was scanned with cone-beam CT. One slice of the CT image was segmented into glandular and fat components and used as a digital phantom for the simulations. Calcium (100, 200, and 300 mg/ml) and iodine (4, 6, and 8 mg/ml) contrast elements were embedded in the glandular region. The x-ray transport process and CT simulations were performed with a 3-mm thick CZT detector and an 80 kVp spectrum. The detector resolved the energy spectrum into 5 energy bins (1-30, 31-37, 38-45, 46-56, and 57-80 keV). A four-material (calcium, iodine, gland and fat) least square fitting procedure was used for decomposition in the image domain. The decomposition technique assumes a dominant material for each voxel. Calibrations were performed with a phantom of 30-70 glandular-breast ratios with calcium and iodine contrast elements of concentrations of 0.03 to 0.53 in 0.5 mg/ml increments and 0.001 to 0.021 in 0.002 mg/ml increments, respectively. After the calibrations were made, different concentrations of calcium and iodine were embedded in the digital breast phantom and were decomposed.
Results: The measured concentrations of calcium and iodine were closely related to their known concentrations. Measured calcium (C_M) was related to known calcium (C_K) as $C_M = 1.02C_K+0.003$ mg/ml. Measured iodine (I_M) was related to known iodine (I_K) as $I_M = 0.98I_K - 0.00001$ mg/ml.
Conclusion: Simulations showed that the four-material decomposition technique could faithfully decompose calcium and iodine on breast computed tomography.