Super resolution CBCT imaging with a dual-layer flat-panel detector

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Purpose: To overcome the intrinsic bottleneck of signal readout speed, spatial resolution and energy separation in conventional single-layer flat panel detector (FPD) based CBCT imaging, an innovative super resolution dual-energy CBCT (DE-CBCT) imaging method, named as suRi, is developed with the dual-layer FPD. Materials and Methods: In suRi, sub-pixel (half pixel in this study) shifted binning is utilized between the two detector layers to double the spatial sampling rate of the dual-layer FPD during signal acquisition. By doing so, high spatial resolution CBCT imaging can be achieved while at high signal readout speed (large detector binning rate). In addition, a penalized likelihood material decomposition algorithm is developed to directly reconstruct the high resolution material bases from the obtained dual-energy CBCT projections. Experiments are conducted with physical phantoms and biological specimen to validate the performance of the proposed suRi CBCT imaging technique. Results: At the same signal readout speed (detector binning level), experimental results demonstrate that the proposed suRi method can improve the image spatial resolution by over 30% compared with the conventional dual-layer FPD based DE-CBCT imaging. Moreover, accurate basis images with high spatial resolution can be directly reconstructed from such dual-energy projections acquired by suRi. Conclusion: A super resolution DE-CBCT imaging method is proposed for dual-layer FPD. It has the potential to greatly enhance the imaging performance of the DE-CBCT systems in future.