Image registration in double-layered x-ray detectors for single-shot dual-energy image reconstruction

Junwoo Kim[1] and Ho Kyung Kim[1,2*]

[1]Center for Advanced Medical Engineering Research, Pusan National University, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan 46241, Republic of Korea
[2]School of Mechanical Engineering, Pusan National University, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan 46241, Republic of Korea
[*]E-mail: hokyung@pusan.ac.kr

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Single-shot dual-energy x-ray imaging (DEI) is based on a sandwich-like detector, which is realized by stacking up two image receptors. In the past, pairs of film-screen systems and photostimulable phosphors was tried as the bases of sandwich detectors, but their image quality was insufficient for practical use. Digital radiographic detectors with higher detective quantum efficiency have regained the attention on the single-shot DEI because they could provide higher quality images at high speed operation. Recent works have showed demonstrations of DE radiography and tomography using digital sandwich detectors. Unlike conventional double-shot DEI, the single-shot DEI is immune to motion artifacts because of the simultaneous acquisition of two-different energy images at a single exposure. Nevertheless, the single-shot DEI requires the procedure of registration between two images because the misalignment of two detector layers is inevitable. This work applies three simple methods of image registration to the sandwich detectors. The rigid method considers translation, rotation, and magnification between two detector layers, assuming that they are placed at the same plane, and incorporates the structural similarity index as a figure of merit for alignment. Two non-rigid methods take into account additionally the tilting angle between the two detector planes: one uses independent feature images acquired using a calibration phantom (offline approach) and the other uses features extracted from images that we want to take (online approach). We compare the imaging performance of the three registration method for the single-shot DEI, as shown in Fig. 1, and the performance includes modulation-transfer function and noise-power spectrum. Pros and cons of the methods are discussed by investgating the registration accuracy and the computation cost.

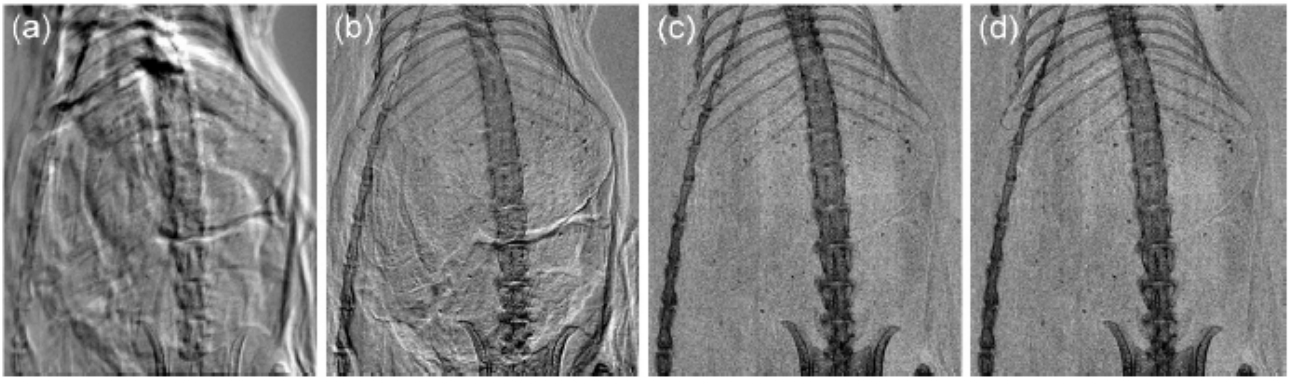

Fig. 1. Single-shot DE bone-enhanced images obtained for a postmortem mouse: (a) no registration showing the bright and dark edges due to misalignments, (b) rigid method, (c) non-rigid method (offline approach), and (d) non-rigid method (online approach).

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