Synthesizing 2D mammographic image from compressed-sensing digital breast tomosynthesis image for reducing imaging dose

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Two-dimensional (2D) digital mammography (DM) has played a important role in clinic for breast cancer screening. However, it has drawn criticism for limited sensitivity and excessive false-positive screening owing to the superimposition of breast tissue [1]. Recently, with the development of full-field DM, digital breast tomosynthesis (DBT) which provides 3D image acquisition has been rapidly gained a role in clinical practice, remedying the shortcoming of the DM. According to previous literatures, DBT alone or combined with DM improves diagnostic ability over standard DM and has the potential to reduce false-positive recalls. However, DBT combined with DM increases radiation dose to patients above that of DM alone, approximately by a factor of two. Thus, developing methods that decrease radiation dose is critical to the widespread acceptance of this imaging modality. One such method to reduce radiation dose is based on the fact that DM can be synthesized from the DBT-reconstructed image (Fig. 1) [2]. In this study, we synthesized a 2D DM from a compressed-sensing (CS)-reconstructed DBT image using a prototype DBT system that mainly consisted of an X-ray tube (28 kV_p and 100 mAs), a CMOS-based flat panel detector (70 μm detector pixel size), and a rotational arm to move the X-ray tube in an arc (Fig. 2). Figure 3 shows our preliminary experimental results: DM images acquired directly from the DBT system and synthesized from the CS-reconstructed DBT image. According to our results, CS-based reconstruction algorithm yielded DBT images of high quality, compared to the filtered backprojection (FBP)-based reconstruction algorithm. In addition, the image quality of the synthesized DM was better in visualizing of the structural details of the breast, verifying the efficacy of the proposed approach. Consequently, we successfully reconstructed DBT images of substantially high image quality by using the CS-based algorithm and synthesized 2D DM from the resulting CS-reconstructed DBT image. More quantitative simulation and experimental results will be presented in the paper.

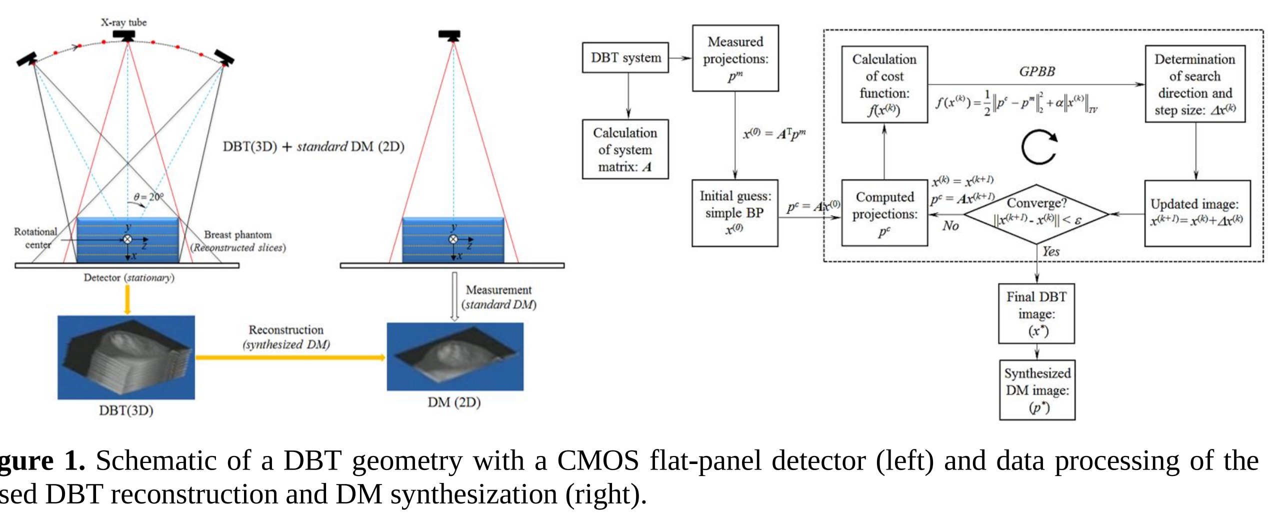
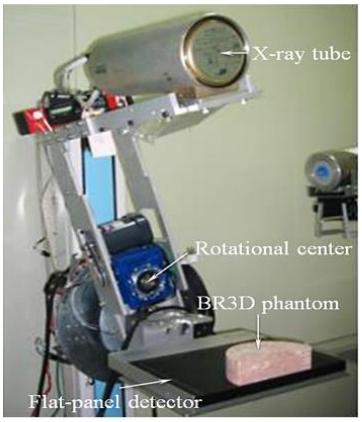


Figure 1. Schematic of a DBT geometry with a CMOS flat-panel detector (left) and data processing of the CS-based DBT reconstruction and DM synthesization (right).



Parameter	Dimension
source-to-detector distance	665.9 mm
pivot-to-detector distance	20.9 mm
tomographic angle	20°
angle step	2°
pixel size	0.28 mm × 0.28 mm
voxel size	0.5 mm × 0.5 mm × 0.5 mm
voxel dimension	100 × 240 × 400
phantom	BR3D mammographic
Reconstruction algorithm	CS-based, FBP-based
Number of iterations in CS	100

Figure 2. DBT system used in this study (left) and parameters used in the DBT reconstruction. The system consists of an X-ray tube (28 kV_p, 110 mAs), a CMOS flat-panel detector with a 70 μm pixel size, and a rotational arm to move the x-ray tube in an arc.

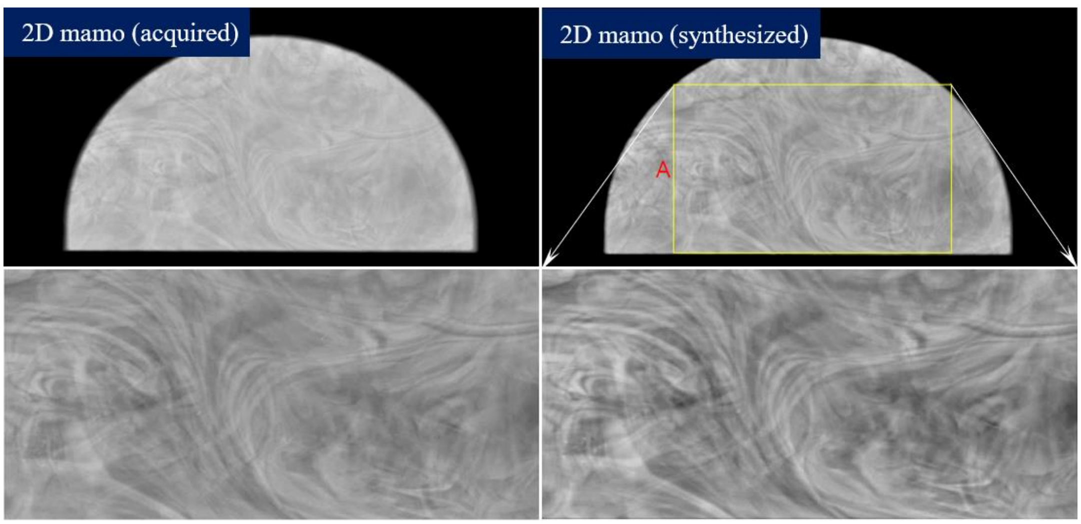


Figure 3. Preliminary experimental results: standard DM directly acquired from the DBT system (left) and synthesized DM from the CS-reconstructed DBT image (right).

Reference

[1] E. Rafferty et al., Radiology, **266** (2013), 104–113.
[2] H. Welch et al., JAMA Internal Medicine, **173** (2014) 448–454.