

Breast shape reconstruction during digital breast tomosynthesis based on discrete algebraic reconstruction technique

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Purpose:

Digital breast tomosynthesis (DBT) is an emerging breast imaging technique that can complement conventional digital mammography. DBT has a limited-angle configuration unlike other conventional computed tomography; thus, high-quality 3-dimensional image reconstruction is impossible. Especially in the case of a narrow-angle-DBT with a rotation angle of fewer than 20 degrees, even shape characterization becomes difficult. However, if breast shape information is known during the DBT, it can be applied to various fields: reconstructed image quality enhancement, scatter correction, breast density estimation, image registration, and image segmentation.

Materials and Methods:

In this study, we propose a method to reconstruct compressed breast shape during DBT when breast thickness projection is prepared. Breast thickness projections can be calculated by the use of the deep learning network which was proposed in our previous study. Morphological operations were added in the vanilla discrete algebraic reconstruction technique (DART) to assure the feasible breast shape of the reconstructed image. Since the compressed breast shape during the DBT should be generally convex, not allowing any holes and extreme concave structure, morphological closing operation, and flood-fill based operation are done after each iteration of DART.

Results:

Compressed andromorphic breast phantoms were generated via the VICTRE and were used for numerical investigations. DBT projection geometry was simulated with the source-detector distance of 660 cm, and the detector was assumed to be at the rotation center. The rotation angle spans from -9.0° to 9.0° , and the total number of projections was 11. We verified our algorithm with both ideal thickness projections and thickness projections obtained using our previously proposed method.

Conclusions:

Our phantom study shows that the proposed algorithm based on the DART and morphological operation is capable to provide more accurate reconstruction than the vanilla algebraic reconstruction algorithm and original DART.

Keywords:

Digital breast tomosynthesis, breast shape reconstruction, discrete tomography, DART, morphological operation