[KAIST Research Group of Future Emerging Technology on Medical Imaging]

Group C

Improved digital breast tomosynthesis images using deep neural networks

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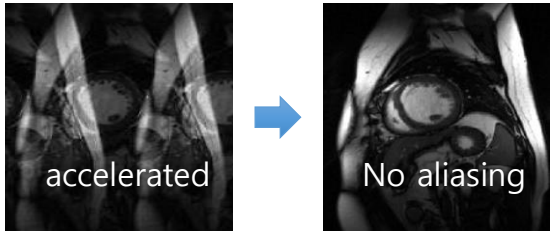
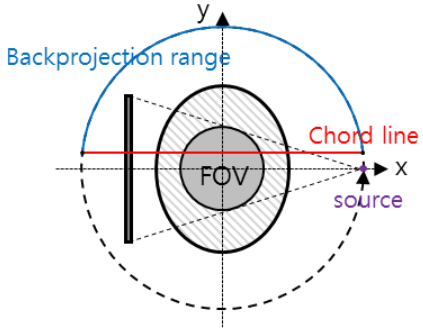
BISP Lab

- Advanced signal processing for bio-medical imaging (MRI, CT, Optics, etc.) using mathematical tools.
- Compressed sensing theory (ALOHA)
- Machine Learning / Deep Learning for bio-medical imaging

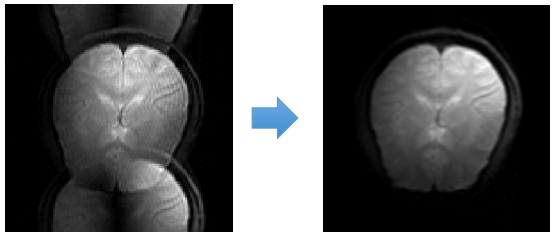
MRI acceleration (k-t FOCUSS)



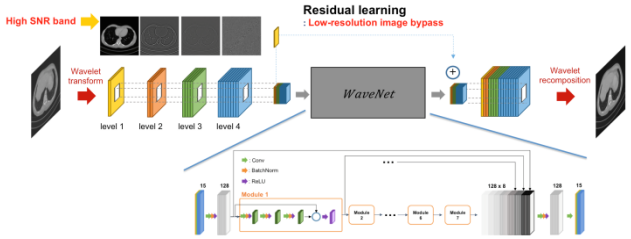
CT interior tomography



MR artifact removal (ALOHA)



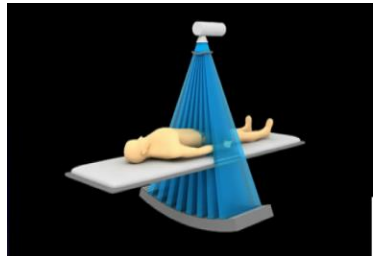
Deep learning approach



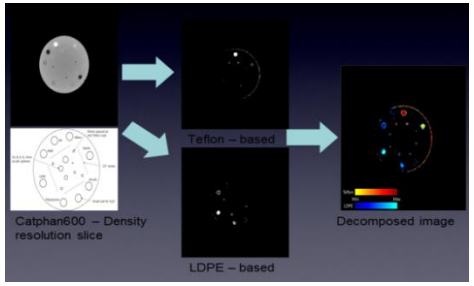
MIR Lab

- Safe & Optimized CT (Dual-Energy, Sparse sampling, Deep learning, 4D CT)
- Functional & Task-specific CT (Photon counting, Multi-gamma Source)
- Radiation Therapy

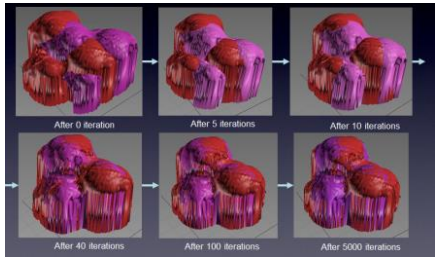
Sparse-sample CT (MVUS)



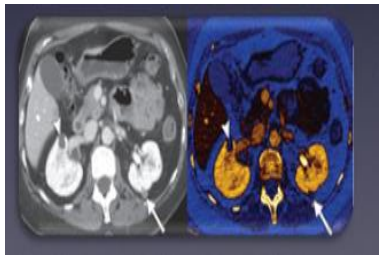
Low dose dual-energy imaging



Atomic Force Microscope

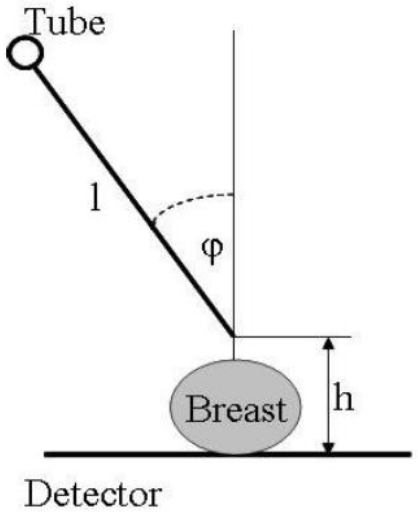


Photon Counting Detector

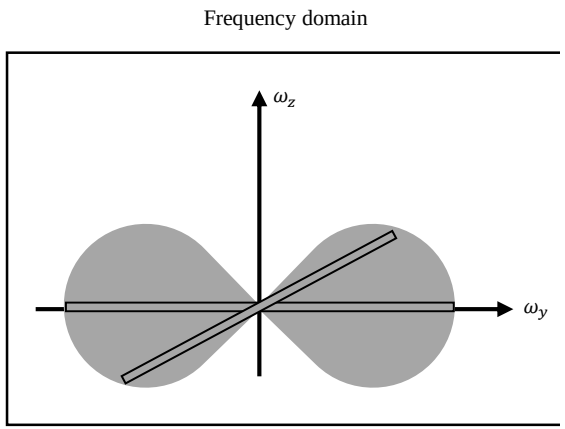


Digital Breast Tomosynthesis (DBT)

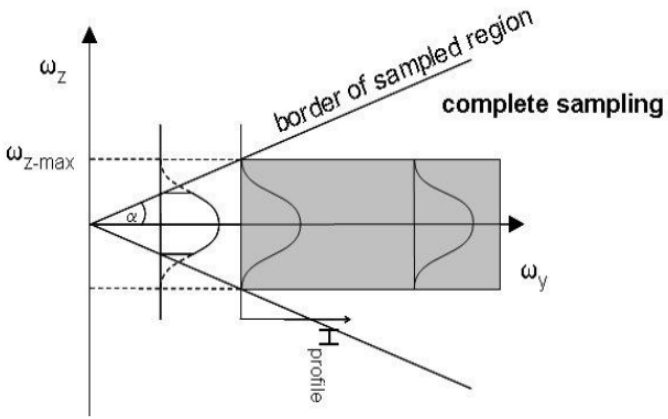
DBT Geometry



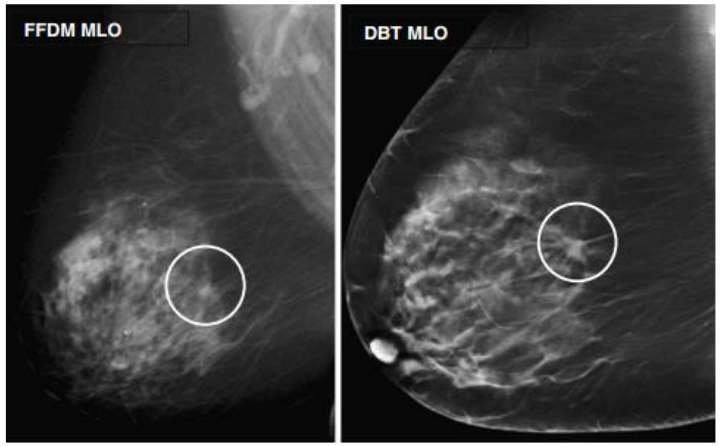
Limited Sampling



Filtering



3D Reconstruction

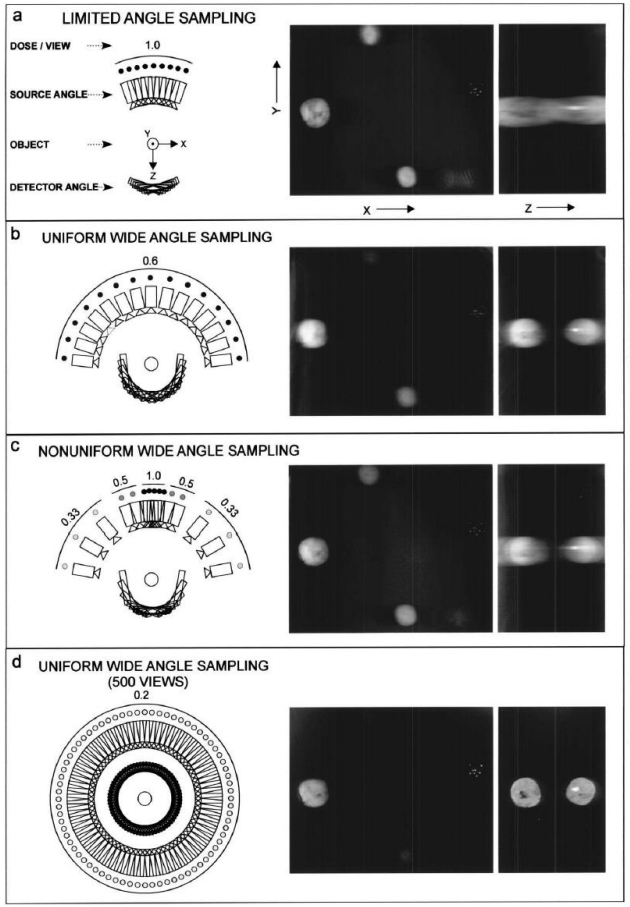


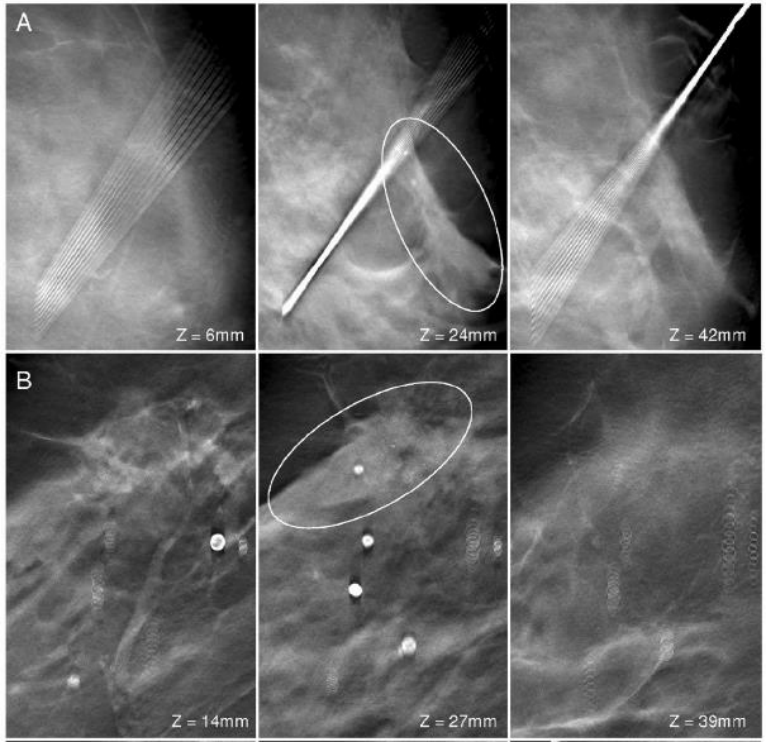
- DBT uses few projections acquired from a limited scanning angle.
- Feldkamp-Davis-Kress(FDK) algorithm with modified filter design is widely used for image reconstruction.
- Iterative reconstruction algorithms (OSEM, MLEM,…) require long computation time.

Mertelmeier, Thomas, et al. "Optimizing filtered backprojection reconstruction for a breast tomosynthesis prototype device." *Medical Imaging*. International Society for Optics and Photonics, 2006.
Gennaro, Gisella, et al. "Digital breast tomosynthesis versus digital mammography: a clinical performance study." *European radiology* 20.7 (2010): 1545-1553.

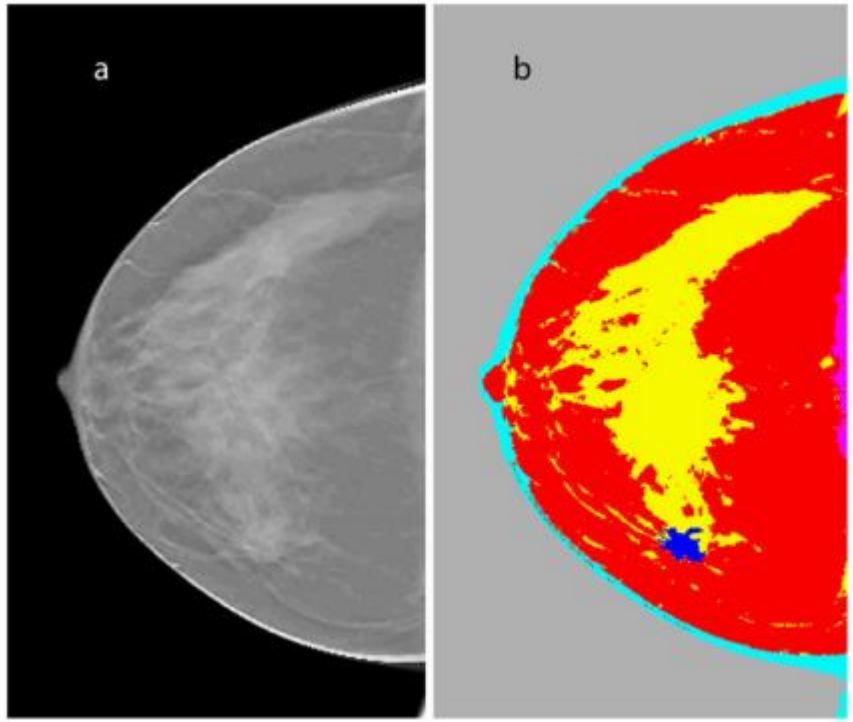
Out-of-plane Artifacts

Lesion localization & Contamination





Segmentation for multimodal imaging



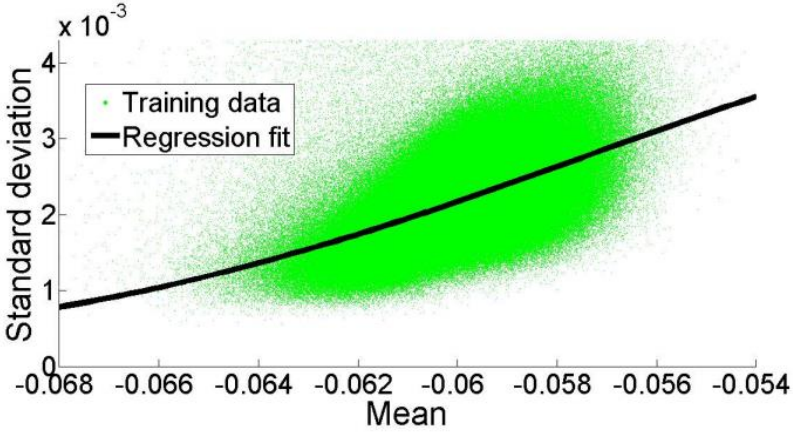
Wu, Tao, et al. "Tomographic mammography using a limited number of low-dose cone-beam projection images." *Medical physics* 30.3 (2003): 365-380.

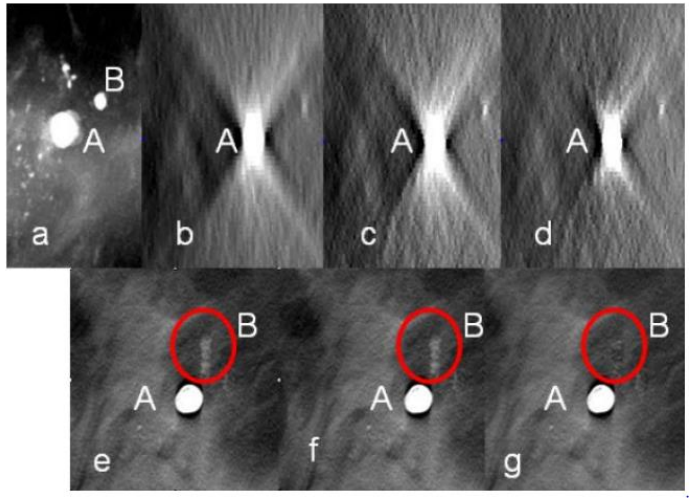
Wu, Tao, Richard H. Moore, and Daniel B. Kopans. "Voting strategy for artifact reduction in digital breast tomosynthesis." *Medical physics* 33.7 (2006): 2461-2471.

Vedantham, Srinivasan, et al. "Semi-automated segmentation and classification of digital breast tomosynthesis reconstructed images." *Engineering in Medicine and Biology Society, EMBC, 2011 Annual International Conference of the IEEE*. IEEE, 2011.

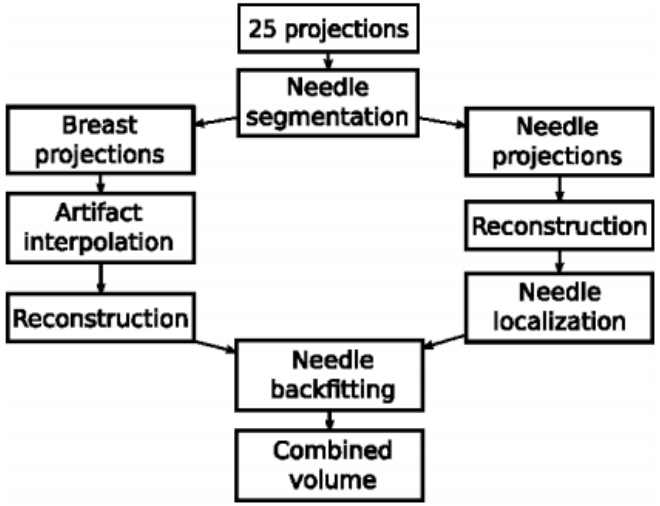
Existing Out-of-plane Artifacts Reduction Approaches

Outlier Detection





Segmentation based approach

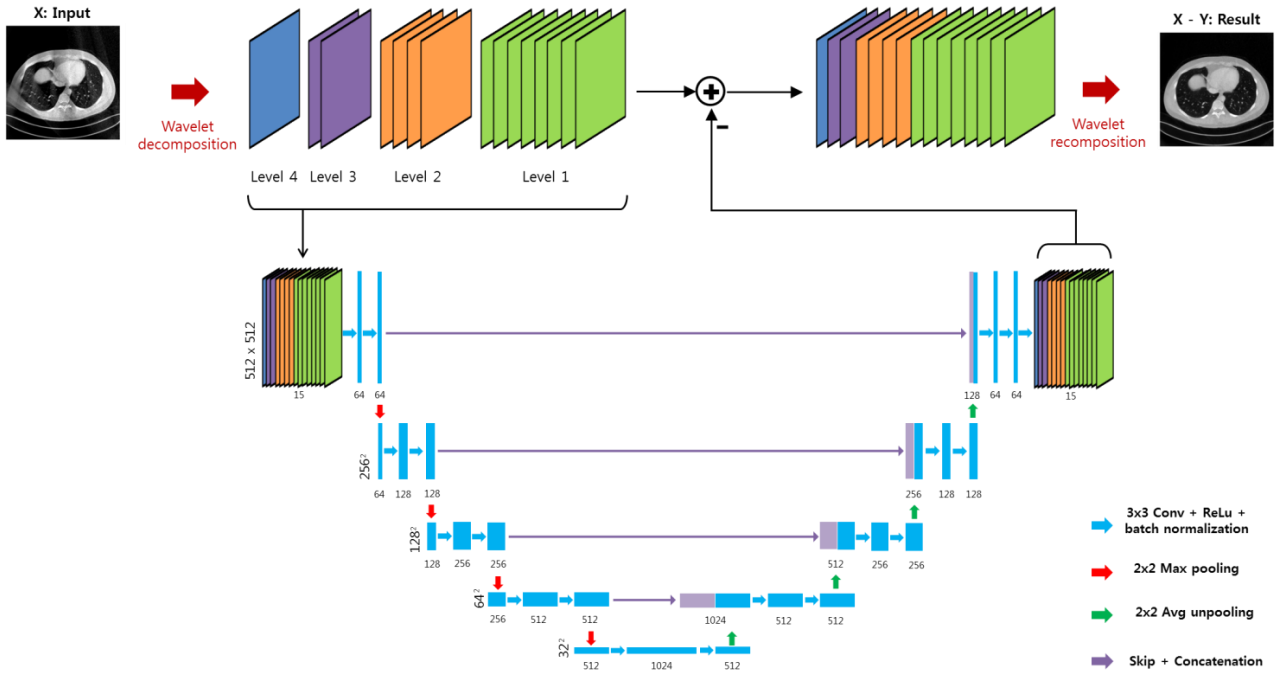


- Performance of many approaches significantly dependent on segmentation results.
- The approach using data redundancy requires prior data.
- The approaches utilizing z-direction filtering often lead to blurring in the image.

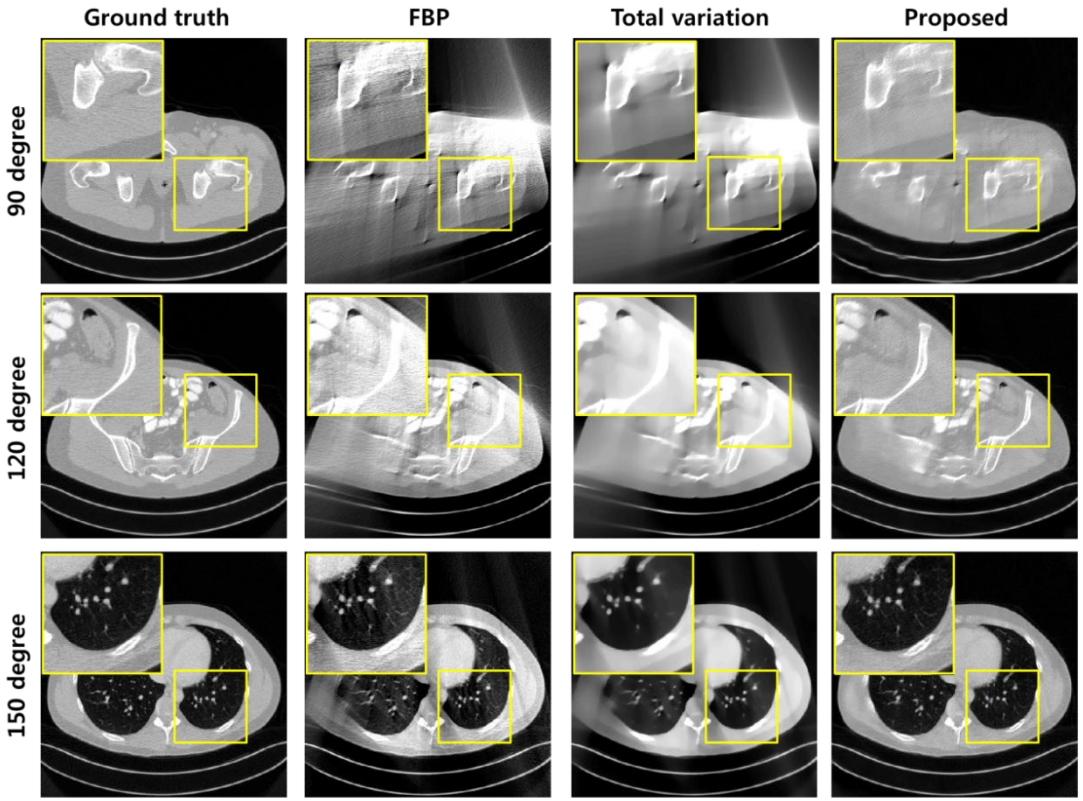
Abdurahman, Shiras, et al. "Out-of-plane artifact reduction in tomosynthesis based on regression modeling and outlier detection." *International Workshop on Digital Mammography*. Springer Berlin Heidelberg, 2012.
Jiang, Zhengning, et al. "Metal Artifact Reduction of Biopsy Needles in Digital Breast Tomosynthesis."

Deep learning for biomedical imaging

Deep residual network for limited-angle CT



Results



Gu, Jawook, and Jong Chul Ye. "Multi-Scale Wavelet Domain Residual Learning for Limited-Angle CT Reconstruction." *arXiv preprint arXiv:1703.01382* (2017).

Thank you!
Any comments?