Real Time Tomography, LLC

Improving Diagnostic Accuracy and Clinical Workflow

Dynamic Reconstruction and Rendering™

of 3D Tomosynthesis Images

Summary

Real Time Tomography's Dynamic Reconstruction and Rendering™ (DRR) technology overcomes many of the clinical challenges of digital breast tomosynthesis (DBT) for breast screening and diagnosis. DRR's patent-pending method enables real-time, on-demand reconstruction of tomosynthesis images at any depth, angle and magnification. These features provide radiologists with a greater ability to view, interrogate and interpret tomosynthesis images and enable optimal image presentation for different breast tissue densities and lesion types. The following offers insight into how the DRR technology facilitates an efficient clinical workflow for DBT and improves clinicians' diagnostic performance.

Digital Breast Tomosynthesis – 3D Imaging

Digital breast tomosynthesis (DBT) is an investigational three-dimensional (3D) imaging modality in which 15 to 49 x-ray projection images are acquired over a limited angular range, typically 15° to 60°, while the breast is held in compression. A set of projection images is obtained at a radiation dose comparable to projection mammography.

After acquisition, the projection images are reconstructed into high-resolution tomosynthesis images. These reconstructed images provide cross-sectional views of the breast, eliminating the problem of overlapping tissue in conventional projection mammography which can obscure lesions or cause false positives (see Figure 1).[1] As a result, *DBT provides improved visualization and localization of suspicious objects*. In clinical trials to-date, DBT has been shown to improve sensitivity and specificity relative to projection mammography.[2, 3] At the time of this publication, FDA approval of DBT for clinical use is pending in the United States, although DBT has been approved in many other countries.

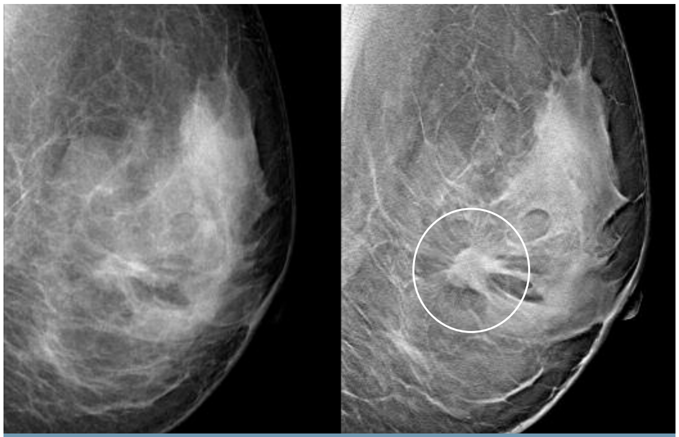

Fig. 1 - Overlapping dense tissue in the mammogram (left) obscures the spiculated mass that is currently evident in the DBT image (right).

DBT Clinical Workflow Challenges

While DBT provides greater sensitivity and specificity, it generates more images for the radiologist to review compared to mammography. This is a major challenge for the practical implementation of DBT in the clinic. The current protocol recommended and implemented by most DBT manufacturers requires reconstructing images in 1 mm slice increments which translate into 30 to 100 images per DBT exam. Without innovation in display methods, the time required to interpret a DBT case is likely to be much longer than the time required to interpret a conventional mammogram. For clinical and commercial viability, DBT must meet the need for high-throughput in both breast screening and diagnostic imaging while maintaining the stringent image quality requirements of breast imaging.

Dynamic Reconstruction and Rendering

Real Time Tomography's Dynamic Reconstruction and Rendering™

Real Time Tomography has developed a patent-pending Dynamic Reconstruction and Rendering™ (DRR) technology that delivers real-time, on-demand image reconstruction and display of DBT images. With DRR, DBT images can be reconstructed in real-time, facilitating higher throughput and an efficient clinical workflow. Post-acquisition processing is eliminated so that radiologists can immediately review the images *during* diagnostic exams and the technologists can verify patient position and image quality at the time of acquisition. This reduces patient callback and enhances clinical efficiency.

DRR provides radiologists greater flexibility and improved visibility of the image data. DRR reconstructs images at any depth specified by the radiologist rather than at fixed slice increments. With fixed slice increments, an object located between two reconstructed slices, such as a calcification, is blurred and can be potentially missed. DRR can position the reconstruction plane so that any object is exactly in focus. This includes objects that are oriented at an angle to the detector; in DRR the reconstruction plane can be angled with respect to the detector plane. As an example, the angle of the reconstruction plane in Figure 2 has been tilted 7 degrees to better view the calcified vessel. Note that the range of angles is specific to each tomosynthesis system geometry.

When magnifying an image, other manufacturers use interpolation to increase the size of the object on the screen without providing any real improvement in image quality. DRR uses the principle of tomographic super-resolution to provide a unique reconstruction for every magnification at *the full resolution* of the displayed region of interest in the breast. The result is a higher level of detail in the image when magnified, especially of microcalcifications (see Figure 3). This can obviate the need for diagnostic magnification mammography, in some cases reducing recall rates. It provides physicians with an important tool when performing diagnostic tomosynthesis not offered by other manufacturers.

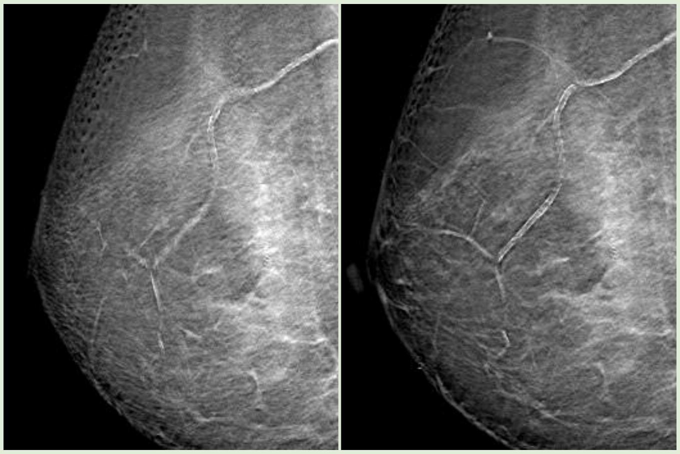

Fig. 2 – At left, the plane of reconstruction is parallel to the detector plane and, at right, the plane of reconstruction is tilted 7 degrees to the detector plane. The calcified vessel is more visible by tilting the reconstruction plane to follow the vessel's orientation.

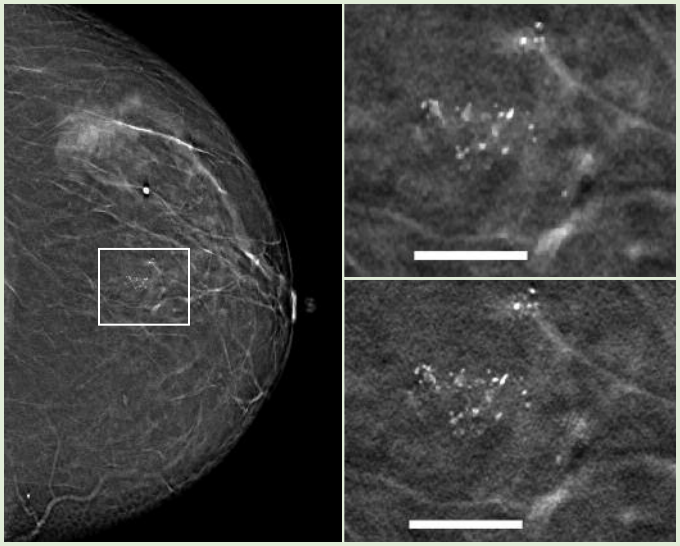

Fig. 3 – A cluster of microcalcifications is located in DBT image (left). The calcifications are more visible and conspicuous in the DBT image reconstructed 4X magnification by DRR (bottom right) compared to the interpolated image (top right). The white bar is 1cm long.

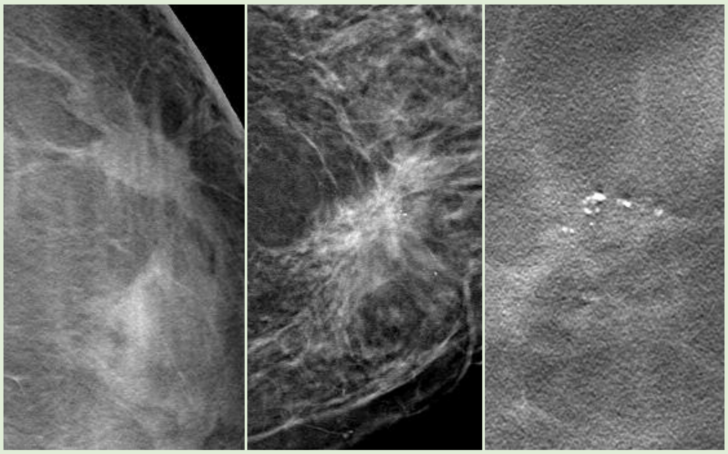

Fig.4 – Lesions are enhanced in real-time to display a spiculated mass (left), a mass with microcalcifications (middle), and a cluster of microcalcifications (right).

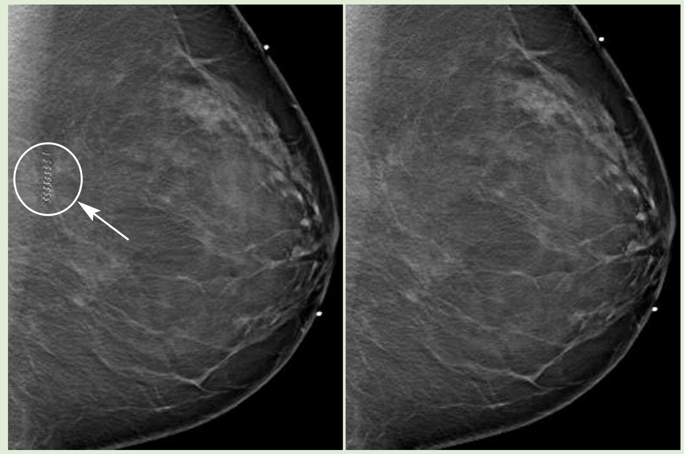

Fig. 5 – At left, the reconstructed image is shown outside the focal plane of the surgical clip. At right, the artifacts from the surgical clip have been eliminated with DRR.

The principle of super-resolution also results in superior spatial accuracy. Researchers at the University of Pennsylvania have shown that measurements of length made in images produced with DRR demonstrate an accuracy of about 1/10 of a pixel; far superior to conventional reconstructions. Whether in measuring the size of a finding or positioning a needle, DRR provides superior accuracy.[4,5,6]

One of the most important advantages of DRR is the ability to clinically target image reconstruction parameters for the optimal presentation of the DBT image for different breast tissue densities and lesion types. Studies have shown that the conspicuity of breast lesions is dependent on the breast tissue density surrounding the lesion, which in turn, is highly dependent on the image processing applied.[7] Current reconstruction methods use a fixed set of image processing settings for all tissue and lesion types. Again, DRR provides superior diagnostic ability, allowing radiologists to change the image reconstruction and processing parameters dynamically or to select from a set of pre-defined parameters for better tissue visibility and conspicuity based on the lesion type being viewed (see Figure 4).

DRR's unique algorithms also enable volume reconstructions, such as maximum intensity projections (MIPS), slice averaging ("slabbing") and advanced image processing techniques such as noise suppression and artifact reduction (as shown in Figure 5). Using commercial graphic processor unit (GPU) technology, DRR eliminates the need for customized hardware solutions and leverages the rapid advances in GPU performance to deliver DBT technology more cost effectively.

Conclusion

Digital breast tomosynthesis is an investigational 3D imaging modality that eliminates the problem of overlapping tissue in projection mammography, while generating substantially more image data for the radiologist to review efficiently compared to mammography. Real Time Tomography has created a Dynamic Reconstruction and Rendering (DRR) technology which facilitates the practical implementation of DBT in the clinic.

Based on patent-pending reconstruction techniques and GPU technology, DRR enables an efficient and economical clinical workflow for DBT and provides radiologists with a greater ability to view, interrogate and interpret 3D image data for more accurate diagnosis. The key features of the DRR technology are:

DRR Enabled Feature	Benefit
Real-time, on-demand reconstruction of images.	**ENABLES** immediate diagnostic review, higher throughput, and interventional procedures. **REDUCES** patient callbacks and data storage needs.
Ability to change image reconstruction and processing parameters in real time.	**OPTIMAL IMAGE PRESENTATION** as images are clinically targeted for different breast tissue densities and lesion types.
View arbitrary planes of reconstruction (depth and angle) in real time.	**GREATER** ability to view and interrogate image data. **REDUCED LIKELIHOOD** of missing small structures, such as calcifications.
Images are reconstructed to the full display resolution for a selected magnification and region of interest in the breast.	**HIGHER** in-plane resolution and image quality during magnification.

About Real Time Tomography

Real Time Tomography, LLC is a privately held company dedicated to developing innovative technologies that increase diagnostic accuracy and improve clinical workflow. Real Time Tomography's software imaging products are cost-effective and provide efficient solutions for manufacturers of medical imaging systems. These solutions can easily be adapted to optimize new and existing systems, accelerating time to market for manufacturer's products.

Susan Ng, M.S.
CEO, Co-Founder

Susan Ng has extensive experience developing market-leading products for the medical, aerospace and semiconductor industries. As a founder of Real Time Tomography, Ms. Ng has defined the vision and direction of the company. She is the principal investigator of the company's scientific grants and has led the company's research efforts in development of its core expertise.

References

1. H. J. Teertstra *et al., European Radiology,* 20(1), 16-24, 2010.
2. S. P. Poplack *et al., American Journal of Roentgenology,* 189, 616-623, 2007.
3. E. Rafferty *et al.*, paper presented at the 93rd Scientific Assembly and Annual Meeting of the RSNA, Chicago, IL 2007.
4. P. Bakic et al., Validation and Optimization of Digital Breast Tomosynthesis Reconstruction Using an Anthropomorphic Software Breast Phantom, SPIE Medical Imaging 2010, San Diego, CA, February 15, 2010.
5. P. Bakic et al., Analysis of Geometric Accuracy in Digital Breast Tomosynthesis, International Workshop on Digital Mammography (IWDM), 62-69, 2010.
6. R.J. Acciavatti et al., Investigating the Potential for Super-Resolution in Digital Breast Tomosynthesis, To be presented at SPIE Medical Imaging 2011, Orlando, FL, February 16, 2011.
7. E. D. Pisano et al., Radiology, 252, 348-357, 2009.

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