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. Figure 1 illustrates a typical DBT acquisition geometry. 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 2) [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 for use in the United States although DBT has been approved for use in many other countries.

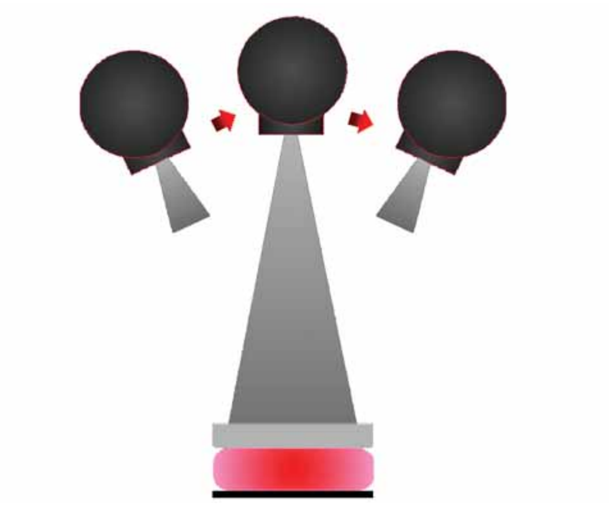

Fig. 1 - Digital Breast Tomosynthesis Acquisition System
The x-ray tube is rotated in an arc around the breast.

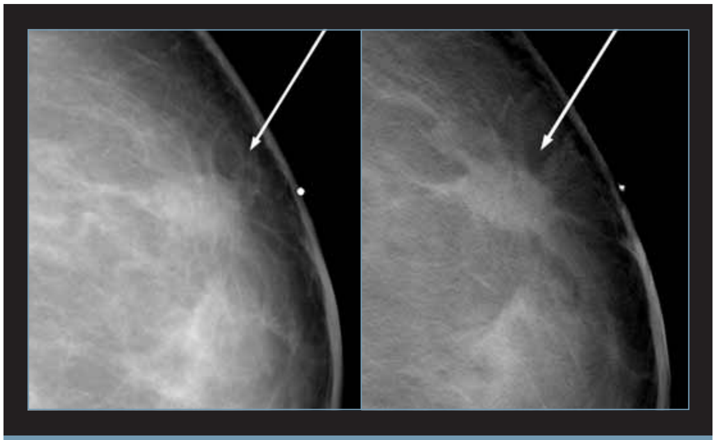

Fig. 2 – A spiculated mass indicated by the arrow in the mammogram (left) is more conspicuous in the DBT image (right).

Dynamic Reconstruction and Rendering

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 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 as well as the stringent image quality requirements for breast imaging.

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 centered between the two reconstructed slices, such as a calcification, is blurred and can be potentially missed. DRR always reconstructs so that the object is exactly in focus. In addition, the reconstruction plane of the DBT image can also be angled (rolled and pitched) in DRR with respect to the detector plane (for a limited range of angles). As an example, the angle of the reconstruction plane in Figure 3 has been tilted 2 degrees to better view the calcified vessel.

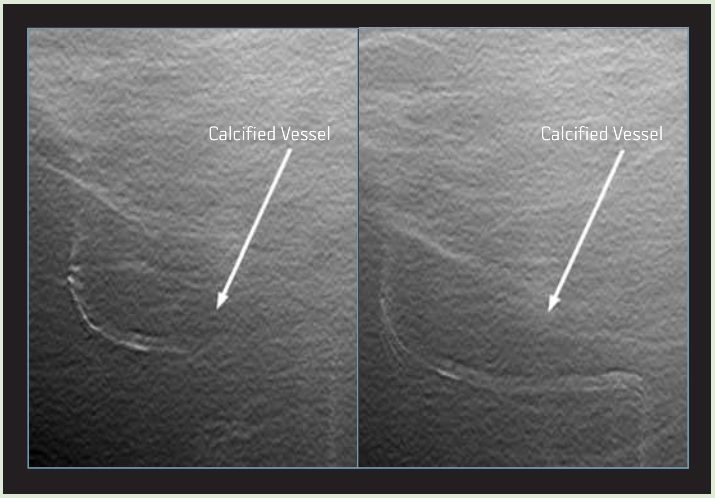

Fig. 3 – At left, the plane of reconstruction plane is parallel to the detector plane and, at right, the plane of reconstruction is tilted 2° to the detector plane.

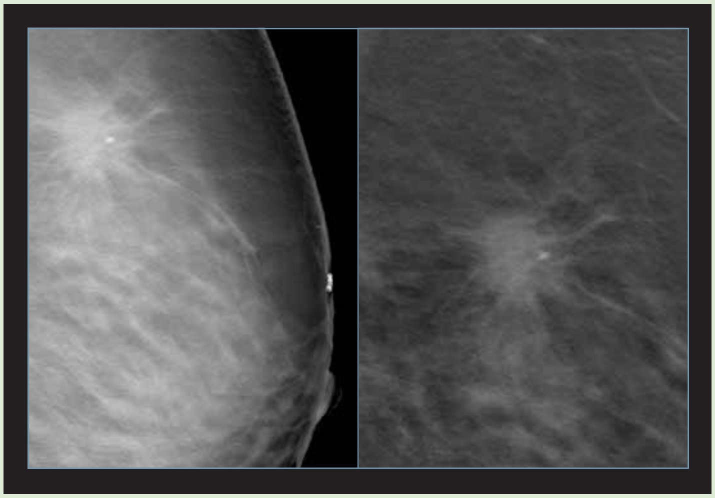

Fig. 4 – DBT Image (left) and reconstructed 3X magnification (right).

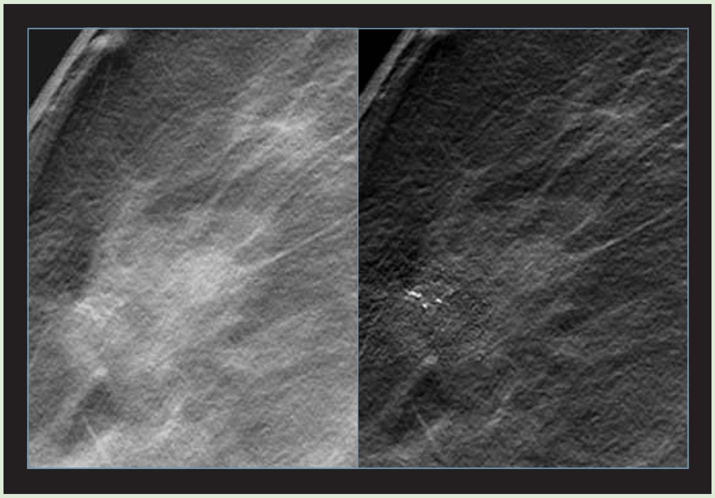

Fig.5 – Calcifications in DBT image (left) are enhanced (right) in real-time.

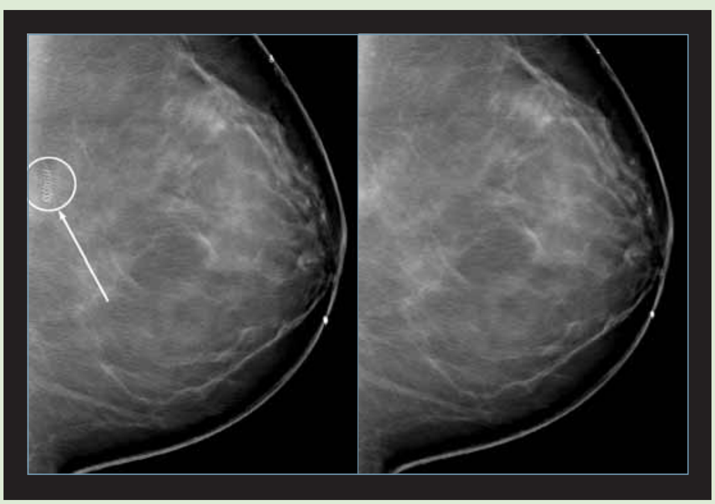

Fig. 6 – At left, the reconstructed image is shown outside the focal plane of the surgical clip. At right, the artifacts from the surgical clip have been eliminated with DRR.

When magnifying an image, conventional methods use an electronic zoom technique in which images that have already been reconstructed are resized so that they simply appear larger on the screen; interpolation is typically used to increase the apparent resolution. In actuality, there is no improvement in image quality because the data encoded in the original reconstructed images is unaltered. With DRR, a unique reconstruction is provided for every magnification at *the full pixel resolution* of the display for the region of interest in the breast. The result is a higher level of detail in the image when magnified (see Figure 4).

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 greatly dependent on the breast tissue density surrounding the lesion which, in turn, is highly dependent on the image processing applied [4]. Current reconstruction methods use a fixed set of image processing settings for all tissue and lesion types. The advantage of DRR is that radiologists can dynamically change the image reconstruction and processing parameters or select from a set of pre-defined parameters for better tissue visibility and conspicuity of the lesion type being viewed (see Figure 5).

DRR also enables advanced image processing techniques such as noise suppression and artifact reduction (as shown in Figure 6). Based on 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 but generates 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 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 manufacturers' products time to market.

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

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