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AUTOMATED THREE-DIMENSIONAL ULTRASOUND BREAST SCANNING IN THE CRANIOCAUDAL MAMMOGRAPHY POSITION

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Ultrasound breast imaging was automated via the development of a computer-controlled, mechanical system which sweeps the linear array transducer across the mammography compression paddle in a sequence of multiple-path, parallel-plane scans. The automated ultrasound scanner (AUS) acquires a sequence of two-dimensional B-mode images which are later reconstructed by computer to form a volume image that can be displayed in various formats. Scan automation results in the ability to image the entire volume of the breast and to view not only the conventional B-mode slices, but also to visualize C-mode planes and side views unobtainable by conventional ultrasound examinations. The C-mode view is parallel to the view obtained by the x-ray system and can potentially be used to spatially register the two imaging modalities. Digitization of the ultrasound data and subsequent volume image reconstruction leads naturally to the ability to store these images in databases for further analysis, teleradiography, and filmless archival of the scans. Further advantages of the automated mode include the convenience of being able to play back the scan in a movie loop to visualize the entire breast volume and to correlate features in x-ray and ultrasound images obtained in spatial registration.

The AUS system consists of a control computer, stepper motor controller, custom two-dimensional mechanical scanner, image frame grabber, commercial ultrasound linear array scanner, and custom software for image acquisition and processing.

In operation, a commercially available linear array is scanned in the X direction, and the video output of the ultrasound unit is digitized at regularly spaced intervals. The transducer is then shifted in the Y direction, and the scan is repeated for as many paths as needed to cover the breast volume of interest. A manual Z axis provides a means to adjust the linear array probe/compression paddle contact force. After the image data is acquired, a volume image is reconstructed from the sequence of B-mode images and displayed to show B-mode and reconstructed C-mode views. With the patient in the cranio-caudal position, the ultrasound volume data is reconstructed by computer to produce image slices which display cranio-caudal, lateral-medial, and posterior-anterior views, where each view can be selected at any depth in the breast volume.

Results obtained by scanning test targets and human subjects confirm that acoustic coupling can be maintained and that ultrasound images through the compression paddle retain their diagnostic quality. Experimental data from scans of an aluminum block, a natural sponge, and human subjects is presented to illustrate the imaging resolution, quality and potential of the approach for application to breast cancer detection.

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