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High resolution breast ultrasound tomography with HARBUT

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Breast ultrasound tomography can produce a map of acoustic properties through the breast, greatly increasing the potential for improved cancer diagnosis. The use of ultrasound is cheaper than MRI and safer than traditional mammography. One particular challenge seen in breast ultrasound tomography is the low resolution caused by ray behaviour commonly assumed in most reconstruction algorithms; by neglecting diffraction effects the algorithm is unable to reliably image small scale features.

(2) Material and Methods

HARBUT (the hybrid algorithm for robust breast ultrasound tomography) has been proposed to combine ray theory with diffraction tomography to enable higher resolution reconstructions to be produced. It uses a ray-based inversion scheme to provide an approximate background image, then uses this to correct a Born-approximation image to reconstruct the fine details. This algorithm was applied to numerically simulated data from a 3D finite difference model, as well as experimentally gathered data. In both cases the setup was an ultrasonic ring array surrounding the breast in a water bath; numerically, 750kHz ultrasound was used, while experimentally the frequency was around 1.1MHz.

(4) Discussion and Conclusion

The HARBUT algorithm has potential for significant improvements in breast ultrasound tomography. There is also potential for further improvements by accounting for 3D effects.

(3) Results

The results confirmed that the algorithm is robust to noise and experimental errors, while generating significantly higher resolution than ray tomography. It is also fast, taking less than a minute to reconstruct in total on a standard contemporary PC.

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