Near field radar imaging in the frequency domain with application to patient data

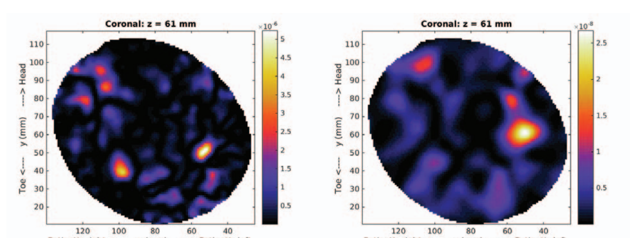
Charlotte F. Curtis and Elise C. Fear
Department of Electrical & Computer Engineering
University of Calgary, Calgary, AB, Canada

Radar imaging in the near field for biological applications has received considerable attention in recent years. Development of this new modality is motivated by differences in the dielectric properties of tissues; in particular, cancerous breast tissue has been found to be significantly different from healthy tissues (M. Lazebnik et al, Phys. Med. and Bio., 52(20), 6093115. 2007). These differences cause scattering of electromagnetic fields and by recording the scattered signals at many antenna positions, the locations of high contrast objects can be determined via image formation.

Tissue sensing adaptive radar (TSAR) is a monostatic approach to radar breast imaging that uses a custom antenna to illuminate the breast with an ultra-wideband pulse and record reflections at up to 300 antenna positions. Initial tests on patients have produced promising results, even with simple time domain delay and sum image formation (E. Fear et al, IEEE Trans. Microw. Theory Techn., 61(5), 21192128, 2013). However, reformulating the time domain imaging algorithm in the frequency domain reveals the assumed physical model and allows for modifications to improve the accuracy of the image.

This work presents the results of applying new frequency domain imaging techniques to previously published patient data. The improvements to the algorithm are first developed and tested on point responses to observe changes in the point spread function. Next, the algorithm is applied to simple models in order to identify which parameters have the most significant impact on the final imaging result. Finally, the same algorithm is used to form images from patient data.

Fig. 1 shows sample images created from the same patient data. While the original time domain method correctly detects the most significant scatterer, the new approach shows greater suppression of background clutter.



(a) Original Time Domain (b) Reprocessed Frequency Domain

Figure 1: Patient images with large tumour located at 3 o'clock