Characterizing the Point Spread Function of a Near Field Ultrawideband Monostatic Radar Imaging System

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Near field microwave imaging has been gaining traction as a viable imaging technique for biomedical applications such as breast cancer detection. Microwave imaging systems, both radar and tomographic, have proven capable of accurately detecting inclusions in models, and results from initial patient studies are promising. However, little is known about the relationship between acquisition parameters and system response such as resolution and sensitivity.

The goal of this work is to develop an expression for the point spread function (PSF) of a near-field monostatic radar system in order to obtain a theoretical limit on image resolution. Analytical results are compared to numerical simulations for verification.

The PSF is an important descriptor of an imaging system. In a traditional modality such as X-ray, a single function representing the impulse response of the system can typically be found. However, the PSF for near-field imaging is not so straightforward, as the response varies depending on the location of the scatterer within the system.

This work presents the PSF of a near field radar system for the scenario of a single point scatterer located at various positions within a cylindrical array of antenna positions. Figure 1 presents a 1D cross section of the PSFs of a centred scatterer obtained both numerically and analytically, showing good agreement between the analytical and simulated results. The full-width at half maximum value of 5 mm suggests that cylindrical near field imaging has more resolving power than predicted by the $\frac{c}{2B} = 8.3$ mm far field range resolution.

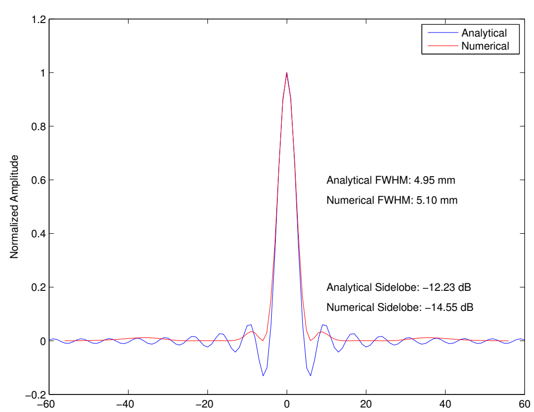

Figure 1: 1D cross section of PSFs obtained analytically and numerically