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Enhanced Resolution Pulse-Echo Imaging

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Ultrasound imaging is a non-invasive, non-ionizing, inexpensive, and portable imaging modality that enables real-time diagnosis. However, ultrasound images suffer from relatively poor resolution. Non-blind and blind deconvolution approaches have been developed for resolution enhancement.

In this thesis, in the context of Z-transform and bounded-output and bounded-input stability, stable inverse filtering for deconvolution is considered first. The constraints for stable inverse filters are derived for Gaussian beam patterns in both narrowband and broadband ultrasound imaging systems. Coherent stable inverse filtering (CSIF) is developed and evaluated for lateral resolution enhancement, where results of parameterized stable inverse filters generated from down-sampled and centered/shifted point spread functions (PSF) are compared. Different strategies are also compared, featuring the harmonic mean calculation. Resolution is enhanced in images simulated using Field II [1, 2] and scanned using a Verasonics V1 (Verasonics, Inc., Kirkland, WA, USA) and an L7-4 transducer (Philips Healthcare, Andover, MA, USA) at 5 MHz. The images include tissue-mimicking phantoms and an in vivo human carotid artery.

The enhanced coherent deconvolution (ECD) framework with accurate PSF sampling and inter-