Bayesian Wavelet Denoising of Ultrasound Images

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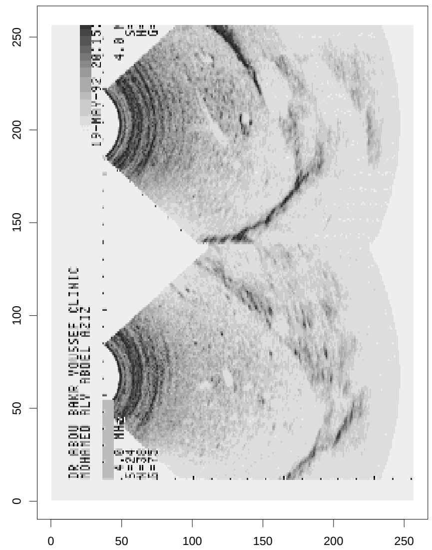
Proposed Research

Wavelet methods of data reduction and analysis are becoming central tools in many areas of modern science and engineering. Multi-resolution techniques provide computationally efficient methods of signal decomposition, and the resulting studies of complex signals at varying scales can reveal structures and patterns not evident in original data nor accessible through more standard methods of data analysis.

Recent work by the investigator, and collaborators, as developed and explored new statistical theory, and methods, of wavelet modelling, and is contributing to the development of a formal foundation for inference in wavelet models as well as refined applied tools ([1],[2]). The current proposal involves further development in a specific application area, that of ultrasound denoising.



The appearance of speckle patterns in ultrasound images is a rather disturbing phenomenon that reduces contrast sensitivity and obscures important details in ultrasound images. The figure on the right shows an ultrasound image of a human liver, in which speckles are visible. It is desirable to "denoise" such images to reduce speckle and enhance real structure in the image. Traditional low-pass filtering (whether adaptive or not) is of dubious value in suppressing speckle effect, and new tools are needed.

This project will develop wavelet methods in the ultrasound image context, aiming to isolate and extract portions of the image energy related to speckle noise. This isolation involves scale isolation based on underlying forms of qualitative prior information describing physical and statistical characteristics of speckles. Ideas and models of adaptive Bayesian model shrinkage, developed by the author ([1],[2]) will be applied in the wavelet domain. Recomposed images are expected to be nearly speckle-free, while diagnostically important small details will not be sacrificed. The approach is novel, and experiments with images of a different nature are most encouraging.

[1] Vidakovic, B. (1994). Nonlinear wavelet shrinkage with Bayes rules and Bayes Factors. Discussion Paper **94-24**, ISDS, Duke University, To appear in *JASA.*

[2] Katul, G. and Vidakovic, B. (1995). The partitioning of attached and detached eddy motion in the atmospheric surface layer using Lorentz wavelet filtering. To appear in *Boundary Layer Meteorology.*