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Ricker子波核支持向量回归的Mercer条件拓展问题研究

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摘要　　Ricker子波核支持向量回归方法是消减地震勘探记录强随机噪声的新滤波技术.用判定支持向量允许核函数的Mercer条件探讨Ricker子波核函数的有效性, 经过数值计算相应的核矩阵的最小特征值, 发现在一个较大范围内存在极小的负值带, 数量级为10^{-13}～10^{-16}, 且在正值带中亦存在10^{-13}～10^{-15}数量级的量.考虑到正负极小量值的计算误差机理相近, 认为判定核函数有效性的Mercer条件在工程应用时有可能适当放宽, 即核矩阵不严格半正定, 接近半正定亦可.为了将Ricker子波核支持向量回归滤波方法向实际应用发展, 本文对不同的理论模型的Ricker子波核滤波和小波变换滤波、自适应维纳滤波这三种技术的效果进行了比较, 包括时域波形、频域振幅谱、滤波前后的信噪比以及均方误差等方面.结果表明, Ricker子波核滤波方法优于另两种方法.为实际应用Ricker子波核滤波方法奠定基础.

关键词　　[Ricker子波核支持向量回归滤波方法](#)　　[Mercer条件拓展](#)　　[混合相位子波](#)　　[强随机噪声](#)　[信噪比](#)　[均方差](#)

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Study on Mercer condition extension of support vector regression based on Ricker wavelet kernel

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Abstract Support vector regression (SVR) based on the Ricker wavelet kernel is a new filtering method for suppressing strong random noise in seismic records. The Mercer condition, which is the rule to determine a support vector admissible kernel, is used to discuss the validity of the Ricker wavelet kernel. By computing the minimum eigenvalues of kernel matrixes, we find that there exist some small negative values in a wider region which have orders of magnitude 10^{-13}～10^{-16}, and also exist some small positive values which have orders of magnitude 10^{-13}～10^{-15}. Considering the same mechanism resulting in the positive and negative computational errors, we conclude that the Mercer condition can be moderately relaxed, that is, the kernel matrix can be not exactly positive semi-definite and close to positive semi-definite. In order to apply the SVR based on the Ricker wavelet kernel to practical applications, we compare the performances of our method, the wavelet transform-based method and adaptive Wiener filtering in detail, including the waveforms in the time domain, the amplitude spectrums in frequency domain, the SNRs before and after filtering and the MSEs. The results show that our method works better than the two other methods, which lays a foundation for practical applications of the SVR based on the Ricker wavelet kernel.

Key words [Support vector regression filtering based on the Ricker wavelet kernel; Mercer condition extension; Mixed-phase wavelet; Strong random noise; Signal-to-Noise Ratio (SNR); Mean Square Error (MSE)](#)

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