



经验模态分解和小波分解滤波特性的比较研究

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The differences analysis on filtering properties of empirical mode decomposition and wavelet decomposition

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摘要 为了更好地了解小波分解(WD)和经验模态分解(EMD)2种方法对非平稳信号滤波特性的差异,以及2种方法的实际应用效果和各自的优缺点,提出了运用对高斯白噪声信号分解分量平均功率谱特性的分析来对比2种方法滤波特性差异的研究方法,并运用多项对比实验对所提研究方法的有效性进行验证.实验结果表明,所提研究方法能够有效地解释2种分解各自的滤波特性.对于EMD分解,各分量平均功率谱表现为带宽逐渐减小,中心频率逐渐降低的一组有序排列的带通滤波器.整个分解过程不需人为干预可自动完成,但存在边缘效应问题,如不加以处理可能会严重影响分解质量;对于小波分解,选择不同小波基,有的表现出与EMD分解类似的多尺度滤波特性,有的则不尽相同,甚至是完全不同.所以小波基的选择和分解层数的设置不同,可能会导致分解结果出现较大差异,因此存在对小波基优化选择问题.此外,小波分解过程速度较快,平均用时仅为EMD的1/25.

关键词: 非平稳信号 经验模态分解 小波分解 滤波器

Abstract: Wavelet Decomposition (WD) and Empirical Mode Decomposition (EMD) are working differently to the filtering properties of non-stationary signals. In order to better understand the differences, their practical effects, advantages and disadvantages, this paper proposes an approach to compare the differences of filtering properties between WD and EMD by using the weight average power spectrum analysis of Gaussian white noise signal. Also, this paper proves the validity of the proposed methods. The experimental results indicate that the methods proposed by this paper can effectively explain the filtering properties of these two decompositions. To EMD, each component weight average power spectrum shows a group of ordered band pass filter in which the bandwidth decreases and the center frequency reduces gradually. The whole decomposition process is automatic but with edge effect which could influence the decomposition quality; to WD, it demonstrates distinct wavelet bases, some show the same multi-scale filtering properties as EMD while the other are distinct, or even completely distinct. Therefore, selecting different wavelets and setting different number of decomposition layers will probably lead to quite different decomposition consequences. The whole process of WD is very fast. Its mean time is only 1/25 of EMD.

Key words: non-stationary signal empirical mode decomposition wavelet decomposition filter

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