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短文与研究通讯

截断效应下平滑信号的稀疏分解方法

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摘要:

存在截断效应时，DFT基下进行平滑信号稀疏分解得到的逼近误差较大，针对此问题，提出一种有效快速的实现方法。该方法根据截断平滑信号的频谱信息确定其所处子空间的位置和个数，然后对信号子空间进行高度冗余扩展生成与之相对应的子字典，将所有子字典级联形成整个字典。构造的冗余字典自适应于待分解信号，相比DFT基和DFT框架，能够更好地反映信号的内在特征；在该字典的基础上，利用其固有的树状结构，改进传统匹配追踪算法，每次迭代中将追踪分成两个层次进行，第一层为粗略搜索，目的在于寻找与信号相对应的子字典，第二层为精确搜索，在相应子字典中寻得与信号最为匹配的原子。改进算法在获得相同精度和收敛性的同时，缩小了搜索空间，降低了计算复杂度。最后，仿真验证了理论分析的正确性和方法的优越性。

关键词： 截断平滑信号； 冗余字典； 树状结构； 稀疏分解；匹配追踪

Sparse Decomposition Method of Smooth Signal under Truncation Effect

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Abstract:

Under sampling truncation effect, the sparse representation approximate error of smooth signal in DFT basis becomes explicit. In order to accurately obtain the sparse representation of a truncated smooth signal, an efficient and effective method was proposed. According to the signal’s frequency spectrum information, this method determines the signal subspaces, including numbers and positions, and redundantly expands these subspaces to form corresponding sub-dictionaries, which are concatenated to generate the whole dictionary. Compared to DFT basis and DFT frame, the designed redundant dictionary is adaptive to the signal and can better reflect its intrinsic characteristics. Moreover, the traditional matching pursuit algorithm is improved by employing the dictionary’s inherent tree structure. In the novel algorithm matching pursuit is divided into two levels at each iteration. The first level search, also called coarse search, is implemented to identify which sub-dictionaries the signal lives in. The second level search, which is also called precise search, is implemented to select the optimal atom at this iteration. This improved algorithm obtains the same accuracy and convergence property with the Matching Pursuit method but can reduce the search space and the computational complexity. Lastly, simulations are implemented to verify the correctness of theoretical analysis and the advantages of the method.

Keywords: matching pursuit.

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