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短文与研究通讯

托普利兹矩阵在压缩多径信道估计中的应用

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摘要：

可靠的无线通信需要准确地知道下层信道的信息，因此需要进行信道估计。而许多真实信道表现为仅有一些相对较少的非零信道系数的稀疏多径信道。对于稀疏多径信道的估计，传统方法例如最小二乘法，没有利用稀疏信道本身的低维度特性，所需训练序列的长度较长，因此估计代价较大。基于压缩感知的信道估计方法，利用稀疏先验信息，能较大地缩短所需训练序列的长度，获得较好的估计效果。该文结合压缩感知观测矩阵的特点，证明了当训练序列的长度不长于信道冲激响应的长度，且托普利兹观测矩阵的行数小于列数时，观测矩阵仍然满足有限等距性质；明确提出了稀疏多径信道估计中所使用的观测矩阵的构造条件。实验结果验证了这种优化了的托普利兹观测矩阵的可行性和实用性。

关键词： 信道估计；稀疏多径信道；压缩感知；观测矩阵；托普利兹矩阵；有限等距性质

Toeplitz Matrix for Compressed Multipath Channel Sensing

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Abstract:

Reliable wireless communication often requires accurate knowledge of the underlying channel, so the channel estimation is needed. Many real-world channels tend to exhibit sparse multipath channels characterized by a relatively small number of nonzero channel coefficients. For sparse multipath channel estimation, conventional methods, such as the least squares, do not use the inherent low-dimension characteristics of these sparse channels, and the required length of the training sequence is comparatively long, so their estimation cost is comparatively large. The channel estimation method based on compressed sensing is able to take full advantage of the prior information of sparsity to obtain a better estimate with greatly reduced length of the training sequence. Combining the characteristics of the compressed sensing measurement matrix, it proves that when the length of the training sequence is not longer than the length of the channel impulse response and the number of rows is smaller than the number of columns in the Toeplitz measurement matrix, the measurement matrix still satisfies the restricted isometry property; and it proposes specific requirements of the matrix structure for the measurement matrix used in sparse multipath channel estimation. Simulation results verify the feasibility and practicality of the optimized measurement matrix.

Keywords: channel estimation sparse multipath channel compressed sensing measurement matrix Toeplitz matrix restricted isometry property

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