Identification of Sparse Time-Varying Underwater Channels Through Basis Pursuit Methods

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Underwater acoustic channels often exhibit extensive time dispersion due to multipath, necessitating the development of powerful algorithms at the receiver and transmitter for reliable performance in digital communication systems. Such impulse responses (IR) are often sparse, a property that has been exploited to improve the performance of adaptive receivers by zeroing small and jitter-prone estimated coefficients. In time-varying channels, responses may be described by (2D) delay-Doppler spread functions (DDSF), which have more parameters than IRs but are even sparser. Motivated by (i) demonstrated significant sparsification gains by simple coefficient truncation at receivers, and (ii) recent developments in compressive sensing algorithms, this work examines the performance of algorithms for L1-L2 basis pursuit (SpaRSA, TwIST) as tools for estimating sparse DDSFs. Their ability to solve a large-scale regularized least-squares problem without explicitly building a dictionary matrix is key for efficiently handling DDSFs. Their performance is compared to matching pursuit approaches (MP, OMP), which have been used previously for similar purposes. The above basis pursuit algorithms are shown to provide better accuracy than MP/OMP with comparable computational complexity in both simulated and real data, and therefore it is found that they merit consideration for inclusion in the signal processing chains of digital receivers.