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High rate acoustic communications based on orthogonal frequency division multiplexing

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Orthogonal frequency division multiplexing (OFDM) offers simplicity of FFT-based implementation with frequency-domain channel equalization, and has emerged as a standard in many terrestrial systems. Its application to underwater systems, however, is challenged by the motion-induced Doppler distortion, which creates non-uniform frequency offset in a wideband acoustic signal. To counteract this problem, recent research has focused on synchronization methods, demonstrating the feasibility of wideband OFDM in initial sea trials. We consider the design of a complete OFDM receiver based on three key techniques: adaptive carrier tracking, spatial diversity combining, and sparse channel estimation. In particular, we focus on time-domain channel estimation, which provides a natural platform for channel sparsing. Sparsing of the impulse response, or discarding of its insignificant coefficients, is shown to offer performance gains on acoustic channels, since they are often naturally sparse. Decision-directed operation, which is made possible by adaptive carrier tracking, yields a low overhead, and further improves the performance of channel estimation beyond that of non-adaptive pilot-based schemes.
The technique proposed is applied to experimental data recorded in a shallow water channel over 1 km. Results show excellent performance of coded OFDM signals, transmitted in the 19-31 kHz band with a varying number of subcarriers.