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Iterative Multiuser Detection for Underwater Acoustic Channels

[Salah A. Aliesawi](#); [Charalampos C. Tsimenidis](#); [Bayan S. Sharif](#); [Martin Johnston](#)

Abstract:

Two different synchronous downlink multiple-access schemes, interleaved-division multiple access (IDMA) and code-division multiple access (CDMA), are considered for pragmatic underwater communications channels exhibiting extended multipath spread and time variability. Two single-element DFE-IDMA and DFE-CDMA receivers are proposed that utilize chip-level adaptive decision feedback equalization (DFE) and carrier phase tracking along with iterative interference cancellation (IC) and channel coding. The receiver equations describing the detection algorithms are derived and their performance is investigated and compared. To track and compensate for the channel effects, the DFE and carrier phase tracking units are jointly optimized based on the mean square error (MSE) criterion and adapted iteratively by exchanging soft information in terms of log-likelihood ratio (LLR) estimates with the turbo processing stage. The detection is implemented by using soft chip cancellation to remove multiple-access interference (MAI) effects between users. The performance of the proposed receiver structures is investigated and compared in short-range shallow-water acoustic channels using offline processing of signals acquired during sea trials in the North Sea. Results for synchronous multiuser scenarios, with two and four users at an effective rate of 439.5 b/s per user, demonstrate that the proposed DFE-based IDMA and CDMA receivers can provide bit error rate (BER) performances of approximately 10^{-5} at an average signal-to-interference-and-noise ratio (SINR) of 11 dB. The experimental results also demonstrate that these direct adaptive receivers have better performance and

significantly mitigate the bit errors associated with the channel estimation (CE)-based IDMA and CDMA receivers with Rake reception while maintaining lower complexity. Furthermore, in some cases, the receivers with partial knowledge of the interleavers' patterns or codes can still achieve performance comparable to t...

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