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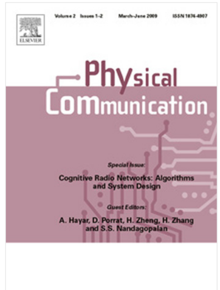

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Reduced-Complexity Sparsity-Aware Joint Phase Noise Mitigation and Channel Equalization in OFDM Receivers

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***Abstract*—A major performance and complexity limitation in direct-conversion broadband wireless transceivers is the phase noise (PN) resulting from the inevitable imperfections in the fabrication process of the crystal oscillator. PN induces inter-carrier interference in orthogonal frequency division multiplexing (OFDM) transceivers. Assuming the availability of inaccurate PN and channel estimates, in this paper, we propose an efficient low-complexity sparsity-based design for joint PN mitigation and channel equalization in OFDM systems. Moreover, we analyze the maximum expected coherence metric for the sparsifying matrix that is used in our approach which provides some insight into its performance. Finally, our numerical simulations demonstrate the effectiveness of our proposed compensation approach compared to the state-of-the-art designs in terms of both performance and computational complexity.**

***Index Terms*—OFDM, Sparse Approximation, Phase Noise, Channel Equalization**

I. Introduction

Orthogonal frequency division multiplexing (OFDM) is a widely adopted modulation scheme in most communications standards such as WLAN IEEE 802.11n [1] and LTE [2] due to its robustness over frequency selective channels and the low-complexity of its per-subcarrier single-tap equalizer. On the other hand, direct-conversion OFDM receivers are sensitive to radio-frequency (RF) impairments such as oscillator phase noise (PN). PN limits the performance of OFDM by destroying the orthogonality between its subcarriers causing inter-carrier interference (ICI).

A plethora of articles exists in the literature where the problems of modeling, analyzing, estimating and compensating the effects of PN on OFDM signals are investigated. For example, while the works in [3, 4] numerically studied the capacity of OFDM systems impaired by PN, in [5], the effects of the Wiener PN and frequency-selective channels on OFDM signals were analyzed in terms of capacity and signal-to-interference-plus-noise ratio (SINR). Furthermore, the authors in [6] built on the work in [5] by assuming that no information about the common phase error (CPE) is available at the receiver. Thus, several bounds on the rate were derived by treating the inter-carrier interference (ICI) induced by PN as noise, arguing that OFDM detection complexity should be kept minimal by only considering the CPE at the detection stage.

Concerning the estimation and mitigation of PN, in [7, 8] the authors considered the estimation and mitigation of the CPE, while PN-induced ICI was ignored. Since the PN-induced ICI is known to have a detrimental effect on the performance of OFDM systems, the work in [9] considered the ICI introduced by PN which was iteratively estimated and then compensated for both Wiener and Ornstein-Uhlenbeck models. In this approach, the PN waveform was estimated and equalized in a decision feedback manner. In [10], the authors extended the work in [9] by proposing a more accurate estimate of ICI where a significant improvement in terms of the symbol error rate is demonstrated.

It is well known that PN changes from one OFDM symbol to another, thus, PN estimates should be updated for each OFDM symbol to maintain a satisfactory performance, which is computationally demanding for both iterative estimation and equalization approaches. Hence, the authors in [11] proposed a non-iterative joint channel and PN estimation technique where the PN is estimated by maximizing a constrained quadratic objective function independent of the channel state information. The improvement shown in [11] is not only limited to a better estimation technique, but also results in a complexity reduction for the PN estimation process. Moreover, in [12], the constraints imposed to solve the optimization problem formulated to estimate the PN

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