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DESIGN OF LOW PAPR PREAMBLE AND PILOT SYMBOL FOR CHANNEL ESTIMATION IN OFDM SYSTEMS

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Abstract. *We present the design of long preambles as well as pilot symbols for orthogonal frequency division multiplexing (OFDM) that jointly captures the aggregate effects of channel estimation error and peak to average power ratio (PAPR). To the preambles and pilot symbols designed to minimize the mean square error (MSE) of the channel estimate, we propose an algorithm based on cross entropy (CE) optimization techniques to design phases of the training symbols in order to minimize peak powers of the training symbols. Compared to the exhaustive search method, the proposed algorithm converges fast to the near optimal solution. Due to its high convergence rate, our proposed scheme has a potential to make practical design of phases for different pilot subcarrier sets. Several design examples including the one consistent with IEEE 802.11a/g are provided to illustrate the superior performance of our proposed method over the conventional standards.*

Keywords: Channel estimation error, Peak to average power ratio, OFDM, Cross entropy optimization, Mean square error

1. **Introduction.** In orthogonal frequency division multiplexing (OFDM) systems, it is not desirable to have peaks of the time domain signals that have significantly higher power than the average power of the signals, as they will increase the peak to average power ratio (PAPR). The consequences of high PAPR are spectral spreading, in-band distortion as well as out-of-band noise (OBN) which deteriorates the system performances. In order to transmit a high-PAPR signal without distortion, either a linear power amplifier (PA) has to be used, or the input signal has to be backed off to the linear region of the PA [1]. Both of these options are low-power efficient. For instance, in the IEEE 802.11a system, the typical power efficiency of a class AB power amplifier is merely 18% [2]. Thus, it is highly desirable to minimize the PAPR of the signal so as to avoid the use of back-off.

For mobile communication systems, power inefficiency leads to the increase of heat dissipation and low battery life of the hand held equipments. Furthermore, high PAPR increases operation cost of the base station. Therefore, to apply OFDM systems to the power-limited as well as band-limited communication systems such as battery-driven portable terminals, peak power reduction techniques play a critical role [3].

In present packet-based wireless OFDM systems, such as IEEE 802.11a/g, preambles have been utilized to estimate and to compensate the impairments that arise at the receiver due to synchronization and channel effects. To ensure better performance, it is highly desirable to have preambles and pilot symbols capable of reducing the effect of PAPR. The long preamble is consisted only of pilot symbols, i.e., a complete OFDM block is known by the receiver.