Multiuser Diversity OFDMA using Power Priority Selection and Adaptive Clipping

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ABSTRACT

In recent, orthogonal frequency division multiple access (OFDMA) has been used for a multiuser wireless communication. In a wireless network, the transmitted signal of each user has independent channel fluctuation characteristic. By using this characteristic, OFDMA can achieve the multiuser diversity (MUDiv). Until this time, to achieve a low complexity and performance improvement, the adaptive subcarrier block (ASB) and frequency symbol spreading (FSS) methods have been proposed. However, the system performance in a low \( E_b/N_0 \) is worse than that of maximal sum capacity (MSC) and peak to average power ratio (PAPR) does not decrease greatly. To solve these problems, in this paper, we propose the subcarrier allocation with the power priority selection (PSS) and the adaptive clipping (AC) with the peak reduction signal to improve the system and PAPR performance.

Keywords: ICI, ISI, MIMO-OFDM, Replica Signals, Scattered Pilot

INTRODUCTION

Recently, LTE-Advanced system and IEEE802.11ac have been standardized (Abeta, 2010 & Comsa, 2012). For these technologies, orthogonal frequency division multiplex (OFDM) has been adopted as a modulation scheme (Cimini, 1985)- (Bingham, 1990). Since OFDM uses multiple subcarriers that are mutually orthogonal, OFDM can achieve high frequency efficiency and high data rate. In general, OFDM allows only one user on the channel at any given time. To accommodate multiple users, a strictly OFDM system must employ time division multiple access (TDMA) or frequency division multiple access (FDMA). Orthogonal frequency division multiple access (OFDMA) is a multiuser OFDM that allows multiple access on the same channel (Koffman, 1999). This is a combination of OFDM and FDMA.
In a wireless network, the transmitted signal of each user has independent channel fluctuation characteristics. By using this characteristic, OFDMA can achieve the multiuser diversity (MUDiv) (Wong, 1999)-(Jiho, 2003). MUDiv/OFDMA shows a good system performance, but it requires a high computational complexity to select the strong subcarrier for each user. To mitigate the computational complexity, adaptive subcarrier block (ASB) method has been proposed (Ida, 2012). In an ASB, a low granularity ASB reduces the signaling overhead such as feedback information. However, a low granularity ASB contains the deep faded subcarriers. Therefore, many errors occur in the deep faded subcarrier due to the frequency selective fading. To solve this problem, frequency symbol spreading (FSS) has been proposed (Ahn, 2012). In this method, a subcarrier data spread in all subcarriers by using the spreading code and the system performance can be improved to mitigate the effect of channel distortion. However, FSS/ASB method has a worse system performance than that of maximal sum capacity (MSC) without using the subcarrier block when $E_b/N_0$ is low. To solve this problem, in this paper, we propose the power priority selection (PPS) method to exploit the diversity using the difference of each subcarrier power after FSS. This method allocates the data on the subcarrier which has good channel response. As a result, the system performance is significantly improved. Moreover, the conventional method still has a large peak to average power ratio (PAPR) (Popoola, 2014)-(Wang, 2011). In an OFDMA, the receiver cannot achieve enough dynamic range due to higher peak signals. When many subcarriers have the approximately same phase, PAPR is increased and the system performance gets worse for the nonlinearity of amplifier. Moreover, the costs and power consumption are to be increased. In this paper, we also propose the adaptive clipping (AC) which decreases peak in time domain adaptively using peak reduction signal corresponding to peak and improve PAPR reduction performance.

**SYSTEM MODEL**

**Channel Model**

We assume that the propagation channel consists of $L$ discrete path with the different time delay. The impulse response for user $m$ is represented as

$$h_m(\tau, t) = \sum_{l=0}^{L-1} h_{m,l}(t)\delta(\tau - \tau_{m,l})$$

where $h_{m,l}(t)$ is the complex channel gain and $\tau_{m,l}$ is the delay time of $l$-th propagation path for user $m$. The channel transfer function is the Fourier transform of and it is given by

$$H_m(f, t) = \int_{0}^{\infty} h_m(\tau, t) \exp(-2j\pi ft) d\tau = \sum_{l=0}^{L-1} h_{m,l}(t) \exp(-2j\pi ft_{m,l})$$

**ASB-FSS/OFDMA**

The transmitter block diagram of the proposed system is shown in Figure 1(a). The binary data sequence is modulated, and $N_p$ pilot symbols are appended at the beginning of the sequence. Then the proposed transmitting signal for user $m$ can be expressed as

$$s_m(t) = \sum_{i=0}^{N_{d}+N_{c}N_t-1} g(t - iT)$$

$$= \left\{ \frac{2S}{N_c} \sum_{k=0}^{N_c-1} u_m(k, i) \exp[j2\pi(t - iT_k)/T]\right\}$$

where $N_d$ and $N_c$ are the number of data and subcarriers, is the effective symbol length, $S$ is the average transmitting power, $T$ is the OFDM symbol length, and is the $k$-th subcarrier of the $i$-th OFDM symbol for user $m$ after the frequency symbol spreading.
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