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α-raised PN code-based MAI cancellation for down-link MC-CDMA systems in Rayleigh fading channels

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Abstract

In this paper, multiple access interference (MAI) cancellation for multi-carrier code division Multiple Access (MC-CDMA). A α-raised PN code code-based MAI interference cancellation scheme in which the conventional transmitter/receiver architecture is minimally modified only at the spreader and despreader is proposed for MC-CDMA communication. Upon numerical and theoretical analyses, the proposed modem is seen to always outperform the existing conventional modem.

I. Introduction

In recent years, there has been a lot of attention concentrated on multi-carrier code division multiple access (MC-CDMA), which is a combination of orthogonal frequency division multiplexing (OFDM) and code division multiple access (CDMA). Much attention has been paid to this technology [1]-[5]. Due to the orthogonality between different subcarriers and spreading code, the spectrum of different subcarrier can be overlapped without inter-symbol interference. Fast Fourier transform (FFT) and inverse fast Fourier transform (IFFT) pair gives also an easy way to implement the multi-carrier modem [6]. However, due to the dispersive fading property of wireless channel environment, orthogonality between subcarriers and spreading code can not be guaranteed. In this paper, we compare bit error rate (BER) between conventional MC-CDMA system using orthogonal code (i.e. Walsh-Hadamard code or Gold code) as spreading code and proposed MC-CDMA system using α-raised PN code to cancel the multiple access interference (MAI).

This paper is organized as follows: In section Ⅱ we briefly derive a mathematical model for MC-CDMA system, as well as wireless channel statistics of MC-CDMA systems. Various detection techniques are considered in section Ⅲ and performance and simulation result are considered in section Ⅳ.

Ⅱ. System and channel model

1. Conventional proposed MC-CDMA transmitter

The MC-CDMA transmitter (base station) is presented in Fig.1. The transmission of a single data bit $d^i \in \{+1,-1\}$ of duration T_b for each user i, $i = 1,2,\cdots,N_u$. Each data bit d^i is spread with its user specific code vector $\mathbf{c}_i$ that is consist of N chips and each chip is of duration $T_c = T_b / N$. The base station has a maximum user capacity of $N_u = N$. As depicted in Fig.1, each user can transmit $M > 1$ bits per symbol. So, the total number of subcarriers is $N_c = MN$ and the symbol duration is $T_s = MT_b$. A guard interval Δ is inserted between adjacent symbols to prevent ISI and ICI. Therefore, Δ must be chosen greater than multipath spread T_m of the channel. The total MC-CDMA symbol duration is $T = T_s + \Delta$. By increasing M, the relative overhead due to the guard interval decreases. But T should not be chosen too large because $T \ll 1/f_{D_{max}}$ ($1/f_{D_{max}}$ is the maximum Doppler frequency) must be guaranteed to assume the channel as a slowly changing frequency selective fading channel.

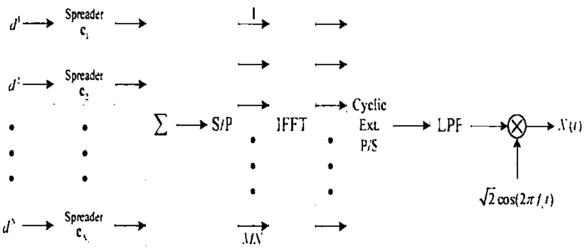

Fig. 1 (a) Block diagram of the MC-CDMA transmitter (base station)

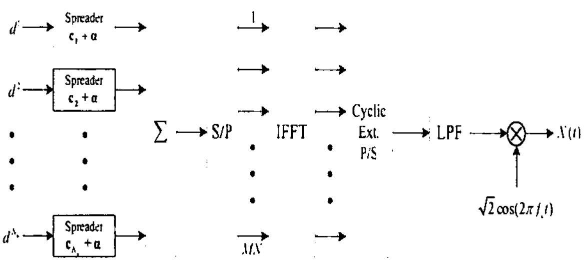

Fig.1 (b) Block diagram of proposed MC-CDMA Transmitter (base station)

After inverse fast Fourier transform (IFFT) and parallel to serial conversion, the transmitted baseband MC-CDMA signal $X(t)$ can be expressed as follows:

$$X_{WH}(t) = \frac{1}{N}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}\sum_{i=1}^{N_u} d_m^i c_n^i \exp\{j2\pi f_{mN+n} t\},\ t \in [0,T] \qquad (1)$$