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HIGH PERFORACE MC-CDMA VIA PHASE ROTATED WALSH-HADAMARD SPREADING CODES

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ABSTRACT

In ordinary multi-transporter CDMA (MC-CDMA) frameworks, twofold spreading codes, for example, Hadamard-Walsh codes are utilized to spread client data over all subcarriers to abuse recurrence assorted variety in recurrence particular blurring channels. We initially recap that in light of the double idea of the spreading codes, transmission control isn't circulated equitably over all subcarriers. Regularly, certain subcarriers have zero transmission control, prompting less decent variety to be abused at recipient. We utilize a stage pivoted spreading code outline and determine the relating joining plan for the stage turned codes. As an immediate outcome, MC-CDMA framework now misuses full assorted variety accessible in the channel consistently, prompting noteworthy execution pick up. Reproduction comes about finished different multi-way blurring channels affirm the execution pick up of the plan.

Index Terms: Bit error rate, Fading channels, Frequency diversity, multicarrier code division multiple access,

Introduction

The framework of multi-carrier code division multiple acess, one of a kind distribution codes are doled out to various users to broaden their data bits over all sub-carriers to misuse frequency diversity in frequency selective diminishing channels. Routinely, binary distribution codes, for example, Hadamard-Walsh codes are utilized. With its fantastic execution in diminishing channels and simplicity of usage through FFT/IFFT, MC-CDMA has pulled in heaps of consideration as of past years. It has been perceived that because of the idea of the distribution codes being utilized as a part of regular MC-CDMA frameworks, the B E R execution of the usually utilized Hadamard change is asymptotically awful. A phase rotated distribution transform was anticipated to accomplish better asymptotic execution. In any case, in past works the distribution code length is thought to be very little.

In this manner, either an optimum maximum likelihood detection Receiver or a sub-optimum linear equalization detection Receiver can be exploited. In the vast majority of MC-CDMA frameworks, it is very coveted to build up a basic yet viable subcarrier consolidating plan that offers superb execution at insignificant many-sided quality. In this paper, we see the phase rotated distribution code design for MC-CDMA framework and derive the minimized mean square error combining (MMSEC) scheme for it. We demonstrate that the MMSEC recipient can adequately exploit full assorted variety and offer phenomenal B E R execution at negligible computational intricacy. The induction of the MMSEC likewise demonstrates that the phase rotated distribution code design reduces the power of multiple access interference into equal parts. Furthermore, we demonstrate that already created carrier interferometer (CI) MC-CDMA (CI/MC-CDMA) frameworks provide phase rotation (and consequently reduced MAI) in most of the sub-carriers. This offers another comprehension of the execution gain of CI/MC-CDMA frameworks.

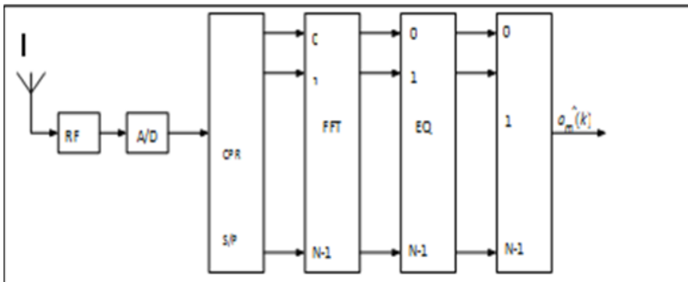
MC-CDMA Transmitter

In MC-CDMA framework, sub-carrier frequencies are usually selected to be orthogonal to every other, i.e., sub-carrier frequencies assure the following condition

$$\int_0^{Tc} \cos(w_i t)\cos(w_j t)\,dt = 0, \text{ for } i \neq j$$

Where Tc chip timing, w_i is i^{th} Frequency and w_j is j^{th} Frequency.

MC-CDMA Receiver



RF:Receive filter
CPR:circular prefix removing
EQ:Equalization

Figure:MC-CDMA receiver for a mobile station

Proposed Method

The broadcast signal of a downlink MC-CDMA framework can be depicted as

$$s(t) = Re\left\{\sum_{k=0}^{K-1} b^{(k)} A \sum_{n=0}^{N-1} \beta_n^{(k)} e^{j2\pi f_n t} p(t)\right\}$$

where K is the aggregate number of dynamic clients, b(k) is the k^{th} client's

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data character (b(k) ∈ {1,−1} if BPSK intonation is utilized $A = \sqrt{\frac{2E_s}{N \cdot T_s}}$ is the amplitude. Es is the character energy, Ts is the character term, N is the quantity of sub-carriers, β(k) n is the nth part of client k's distribution code, fn is the frequency of the nth subcarrier and fn = fc+n•Δf (where fc is the carrier frequency and Δf = 1/Ts to guarantee orthogonality among all sub-carriers, and p(t) is the rectangular pulse shape.

Normally, a binary code matrix C is employed to assign distribution codes to all uk=0sers. The most commonly used distribution code is the Hadamard-Walsh code. In the code matrix C,

$$\mathbf{C} = \begin{bmatrix} \vec{\beta}^{(0)} \\ \vec{\beta}^{(1)} \\ \vdots \\ \vec{\beta}^{(N-1)} \end{bmatrix} = \begin{bmatrix} \beta_0^{(0)} & \beta_1^{(0)} \\ \beta_0^{(1)} & \beta_1^{(1)} \\ \vdots & \\ \beta_0^{(N-1)} & \beta_1^{(N} \end{bmatrix}$$

Where β(k) represents the distribution code of the kth user and β(k) = (β(0) k β(1) k ...β(N−1) k).

It is important to note that the code matrix is binary, i.e., β(k) n ∈ {1,−1}. Hence, oftentimes the broadcast signal has uneven power distribution over all sub-carriers. Particularly, what is most problematic is when some sub-carriers have zero transmission power. Let's use an example to demonstrate this. Assume a MCCDMA framework with N = 8 sub-carriers. A length 8 Hadamard Walsh code is used as the distribution code matrix. The K active users will randomly pick K rows from this matrix as their distribution codes. Assume there are two users on the framework and one user (the 0th user) is using distribution code {1 1 1 1 1 1 1 1}, while the other user (the 1th user) is using distribution code {1 1 1 1 − 1 − 1 − 1 − 1}. When both users broadcast the same data character (for example, b(0) = 1 and b(1) = 1), the binary nature of the distribution codes lead to broadcast signal over the 8 sub-carriers as {2 2 2 2 0 0 0 0 }. Hence, only the first 4 sub-carriers have power and the other 4 sub-carriers are actually not broadcastting anything. This leads to less frequency diversity: only half of the diversity is exploited in this case. This scenario is shown in Figure 1.

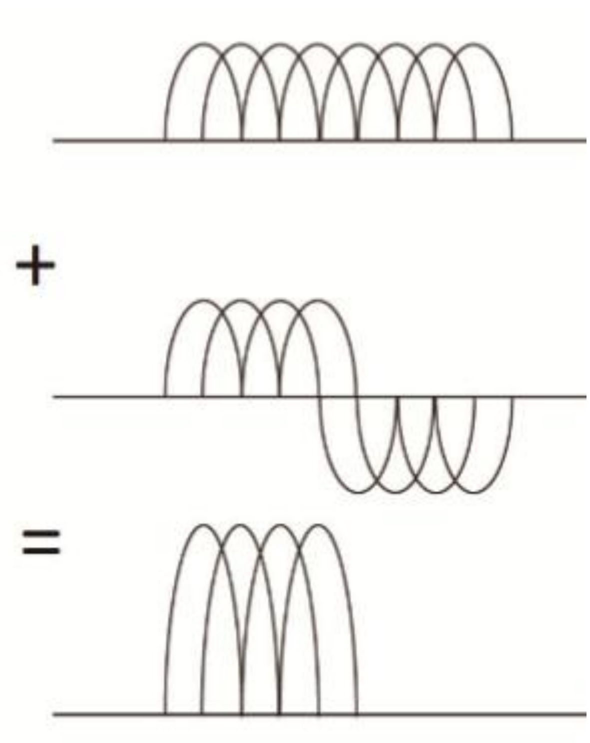

Figure 5.1.1: Uneven Subcarrier Power Distribution 1

If both users are broadcastting the opposite data characters (for example, b(0) = 1 and b(1) = −1), the actual broadcast signal over the 8 sub-carriers becomes {0 0 0 0 2 2 2 2}. Now, only the last four sub-carriers are broadcastting power while the first four sub-carriers have zero power. Therefore, only half of the frequency diversity is exploited.

There are even cases that multiple users' signal accumulates to only one subcarrier containing all the transmission power and all other sub-carriers broadcastting zero power. For example, if all users broadcast data character 1, transmission power will be only on subcarrier 0, while all other sub-carriers have zero power. In these cases, no diversity is exploited at all.

5.2 PHASE ROTATED CODE DESIGN

To solve this problem and bring full diversity to MC-CDMA framework at all times, we employ the phase rotated distribution code design developed by [8]. Particularly, by rotating every row of the distribution code matrix with a different phase, a new distribution code matrix is created that maintains the orthogonality among all rows. However, this new distribution code matrix eliminates the possibility of zero power accumulation on any subcarrier. Therefore, all sub-carriers are actively participating in the deintonation of the data character at Receiver side, exploiting full frequency diversity available in the frequency selective diminishing channel at all times. Figure explains the problem of zero power accumulation. Since user k is broadcastting the product of data character and distribution code bkβk n on the nth subcarrier, user l is broadcastting blβl n, due to the binary nature of the code βk n (and βl n) and the data character bk (and bl, the code/data combination bkβk n is either +1 or −1. Therefore, it is inevitable that sometimes one user's code/data combination will be +1 and another user's code/data combination will be −1 and when they broadcast the signal results in a zero, as shown in Figure 2.

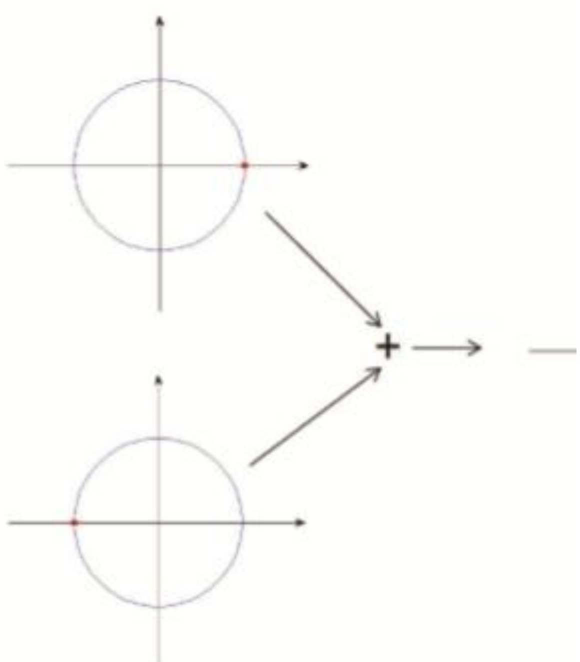

Figure5.2.1: Binary Code/Data Combination

A new distribution code matrix C_{New} can be created by introducing an unique phase offset to every and every row of the original $_n$Hadamard-Walsh code matrix:

$$\mathbf{C_{New}} = \begin{bmatrix} P^{(0)} \cdot \vec{\beta}^{(0)} \\ P^{(1)} \cdot \vec{\beta}^{(1)} \\ \vdots \\ P^{(N-1)} \cdot \vec{\beta}^{(N-1)} \end{bmatrix} = \begin{bmatrix} e^{j\frac{\pi}{N}0} \cdot \vec{\beta}^{(0)} \\ e^{j\frac{\pi}{N}1} \cdot \vec{\beta}^{(1)} \\ \vdots \\ e^{j\frac{\pi}{N}(N-1)} \cdot \vec{\beta}^{(N-1)} \end{bmatrix}$$

As shown in equation (3), a phase rotator P(k) is multiplied to the kth row of the original Hadamard-Walsh code matrix where P(k) = ej π N k. Consequently, every row is rotated by a different amount in the phase gap. It is easy to show that the introduction of the phase rotation does not change the orthogonality of the distribution code matrix, i.e., C_{New} is still an orthogonal matrix. The inner product of the kth row and the lth row of the new code matrix CNew is: < P(k) · ~ β(k),P(l) · ~ β(l) >= P(k) · P∗(l) < ~ β(k), ~ β(l) > (4) Since C is an orthogonal matrix, < ~ β(k), ~ β(l) >= 0,∀k 6= l. Therefore, < P(k) · ~ β(k),P(l) · ~ β(l) > is also 0 for any two different rows in C_{New}.

Therefore, no matter what the code/data combination of every

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user is, it is guaranteed that they will not accumulate to zero. This is shown in Figure 3. In Figure 3, 8 different phases separated by π 8 are introduced to the 8 different users' distribution codes. Therefore, if the original binary code/data combination is +1 for one user, it will pick one of the 8 different points shown in the up-left constellation; otherwise it will choose one of the 8 points in the bottom constellation. However, it is guaranteed that the sum of two different user's signal will not be zero.

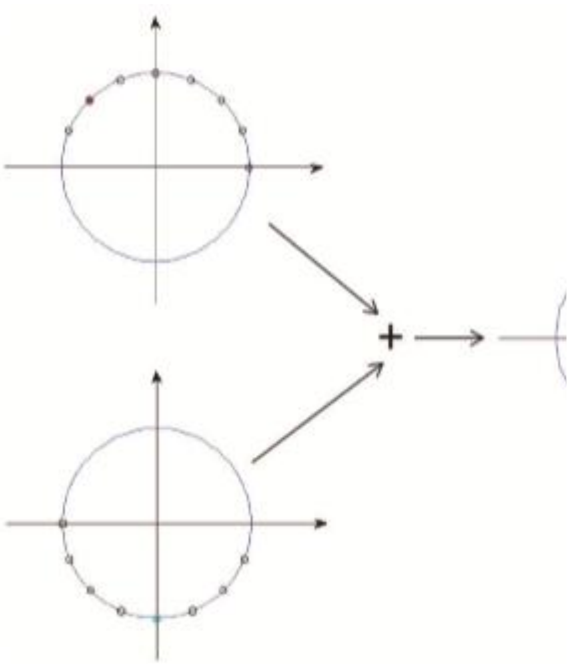

Figure 5.2..2: Phase Rotated code/data combination

Figure shows the generic block diagram of the MCCDMA lth user's Receiver. Note that in the didistribution stage we use β∗(l) n (the complex conjugate of β(l) n) since we now have a complex distribution code matrix instead of a real matrix.

After the didistribution, the nth subcarrier's output is:

$$r_n^{(l)} = A\alpha_n \cdot b^{(l)} + A\alpha_n \sum_{k=0,k\neq l}^{K-1} b^k Re[\beta_n^{(k)} \beta_n^{*(l)}] + n_n$$

Where, αn is the diminishing gain of the nth subcarrier. In equation (5), the first term represents the desired signal of the lth user, the second term represents the multiple access interference (MAI) from the other K−1 users, and the third term represents additive Gaussian noise. Next, a linear combiner combines across all sub-carriers to form a decision variable:

$$R^{(l)} = W_n \cdot r_n^{(l)}$$

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Where, Wn is the combining weight for the nth subcarrier. Since we have assumed BPSK intonation, the MAI in equation (5) only contains the real part of the product of β(k) n and β∗(l) n . Since β(k) n ∈ {ej π N k,−ej π N k} and β(l) n ∈ {ej π N l,−ej π N l}, Re[β(k) n β∗(l) n] becomes:

$$Re[\beta_n^{(k)}\beta_n^{*(l)}] = \cos\left(\frac{\pi}{N}(k-l)\right)$$

or

$$Re[\beta_n^{(k)}\beta_n^{*(l)}] = \cos\left(\frac{\pi}{N}(k+l)\right).$$

Without losing generality, assume l = 0, we can easily derive the minimized mean square error combining (MMSEC) scheme to be:

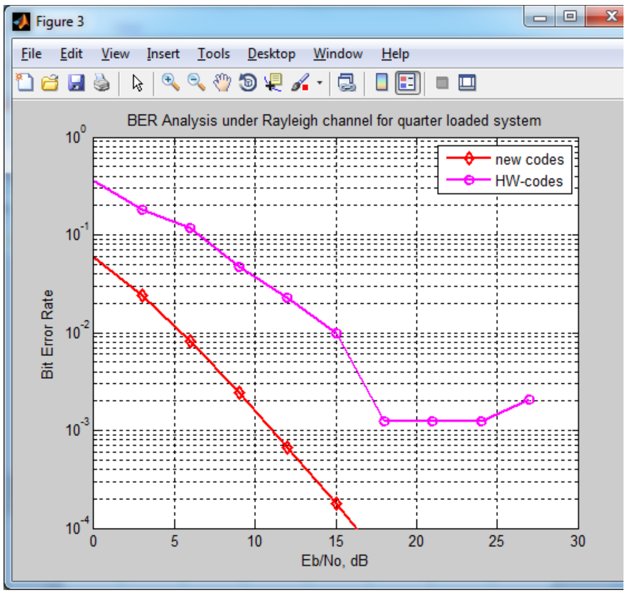
$$W_n = \frac{\alpha_n}{KA^2\alpha_n^2/2 + \frac{N_0}{2}}$$

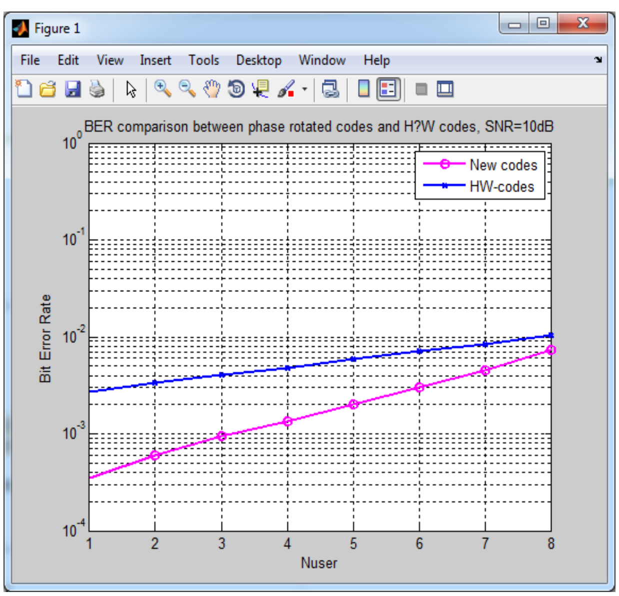
It is important to note that because of the phase rotation, the MAI observed at the MC-CDMA Receiver using the phase rotated codes (with BPSK intonation) at every subcarrier is only half of that when binary Hadamard-Walsh codes are used. Hence, when BPSK intonation is employed, the phase rotation distribution code design provides a two-fold benifit: on one hand, the MAI power is reduced in half; on the other hand, full diversity is always exploited. Unfortunately, the MAI power reduction benefit disappears when high intonations such as QPSK and QAM are employed.

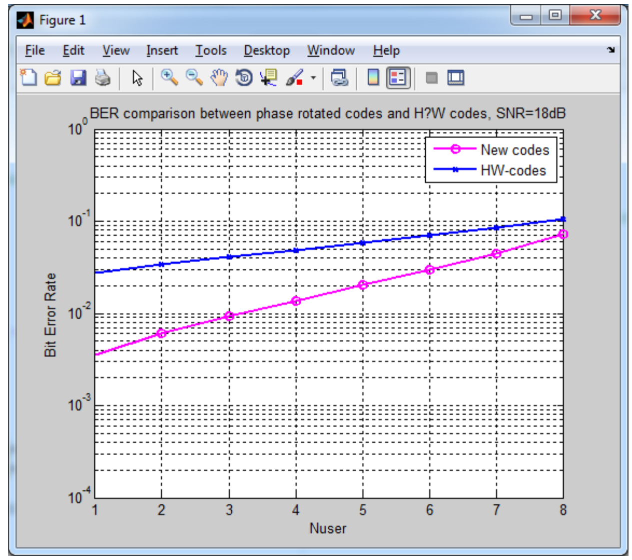
Now let's revisit previously developed CI/MC-CDMA framework [10]. In CI/MC-CDMA framework, the distribution code matrix is the DFT matrix. The kth user's distribution code is:

β (k) =e−j 2π N ·k·0,e−j 2π N ·k·1,...,e−j 2π N ·k·(N−1) (10)It has been shown in that CI/MC-CDMA framework performs MC-CDMA framework employing Hadamard-Walsh codes when BPSK intonation is employed. However, when higher intonation such as QPSK is employed, CI/MC-CDMA no longer offers such performance gain over MC-CDMA with Hadamard-Walsh codes. Now we can provide an explanation of this distinction. On subcarrier n, is β(k) n = e−j 2π N ·k·n. When n = 0, β(k) ·k·0 = 1. When n = N 2 , β(k) n = e−j 2π N ·k· N 2 = e−jkπ ∈ {+1,−1}. In other words, on these two sub-carriers, all distribution codes are binary. However, on other sub-carriers (i.e. 6= 0,n 6= N 2 , the distribution codes from different users are actually phase rotated. As a direct result, CI/MC-CDMA enjoys the same MAI reduction benefit as the phase rotated MC-CDMA framework on N − 2 sub-carriers out of the total N sub-carriers. This is the source of the performance gain of CI/MC-CDMA.

Results







Conclusion

In this paper, we have designed a low complexity minimized mean square error combining scheme for downlink MC-CDMA systems using phase rotated spreading codes. The proposed scheme eliminates the problem of zero power distribution on subcarriers. As a direct result, full diversity is always exploited and significant performance gain is achieved 0 5 10 15 20 25 30 35 10−3 10−2 10−1 BER comparison between phase rotated codes and H−W codes, SNR=10dB Number of Users BER H−W codes new codes in multi-path fading channels. Simulations over various channel conditions and scenarios confirm the effectiveness of the proposed scheme.

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References

[1] S. Hara and R. Prasad, "Overview of multi-carrier CDMA", IEEE Communications Magazine, vol. 35, no. 12, Dec. 1997, pp. 126-133

[2] L. Rugini, "Linear Equalization for Multicode MC-CDMA Downlink Channels," IEEE Communications Letters, vol.16, no.9, pp.1353-1356, September 2012.

[3] T. Miyajima, and M. Kotake, "Blind Channel Shortening for MC-CDMA Systems by Restoring the Orthogonality of Spreading Codes," IEEE Transactions on Communications, vol.63, no.3, pp.938-948, March 2015.

[4] R. Rajbanshi, Q. Chen, A. M. Wyglinski, G. J. Minden and J. B. Evans, "Quantitative Comparison of Agile Modulation Techniques for Cognitive Radio Transceivers", IEEE CCNC2007, First Workshop on Cognitive Radio, Las Vegas, January, 2007.

[5] Z. Wu and C. R. Nassar, "FD-MC-CDMA: A Frequency-based Multiple Access Architecture for High Performance Wireless Communication," IEEE Transactions on Vehicular Technology, vol. 54, no. 4, pp. 1392-1399, July 2005

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