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Single Carrier Equalization in Fading Domain Using SC-FDMA & LTI Channel Domain

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Abstract

In Wireless system transmission of Signal is done through mobile & broadband system. Multipath carrier transmission shows the projection to struggle doubly selective factor but for that we will use concept of single carrier transmission & design a receiver for that purpose. We try to propose a structure of equalizer in fading domain basically based on frequency domain decision feedback which could be used SC-FDMA systems for the multiple users. Some particular parameters of the equalizer are analyzed. An Altamonte-like scheme for combining space–time block-coding with single-carrier equalization in fading domain. With two transmit antennas, the scheme is analyze to achieve significant diversity gains at low complexity over frequency-selective fading channels.

Keywords: *Equalizer, Fast Fourier Transform, BER, Doubly Selective Channel, SFBC.*

1. Introduction

The whole theory is related with the wireless concept because such systems are related with transmission of the signal through mobile & broadband & often they face the big challenge of fading that can be either large scale or small scale & Time selective or frequency selective fading. Fading is a rapid fluctuation of amplitude, phase, and multipath delay of radio signal over a short period of time. So design for proper & effective equalization & estimation of any algorithm for such concept is become a problem. So we try to define a design of a receiver through which we can equalize a single carrier. Single Carrier minimum-mean-square-error frequency- domain equalization (SC MMSE-FDE) is an attractive equalization scheme for broadband wireless channels which are define by their long impulse response memory. SC MMSE-FDE has lower complexity, due to its use of the computationally-efficient fast Fourier transform (FFT), than time-domain equalization whose complexity grows exponentially with channel memory. Single-Carrier Frequency Division Multiple Access (SC-FDMA) has been extensively adopted as a typical uplink transmission method for multi-user access scenarios. Compared with OFDMA scheme, SC FDMA system has its own advantages, such as low Peak to Average Power Ratio (PAPR). Low PAPR can allow the system to relax the specifications of linearity in power amplifier of the mobile terminal, which will reduce the cost and the power consumption.

2. Doubly Selective Channel (DSC)

2.1 Channel is a medium through which data is to sent out or signal is to pass from the source to destination. Some time a change in frequency & wavelength of a wave is defined by user moving relative to source of wave or some time it is defined by multipath factor. So in both case it take both concept of frequency as well as time selective. So the channels noise response are both time selective as well as frequency selective

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is known as doubly selective channel.

2.2 Equalization in Carrier Transmission

Equalization is the process of adjusting the strength of number of frequencies within a signal. The basic & main use of equalization is in recording of sound and reproduction but still there are many other applications in electronics and telecommunications. The equipment used to achieve equalization is called an equalizer. These devices strengthen (boost) or weaken (cut) the energy of specific frequency bands. In telecommunications, equalizers are used to occupy the frequency response—for instance of a telephone line—flat from end-to-end. In sound reproduction, equalization has come to mean the adjustment of frequency responses for aesthetic reasons, which usually produces a response that is not flat.

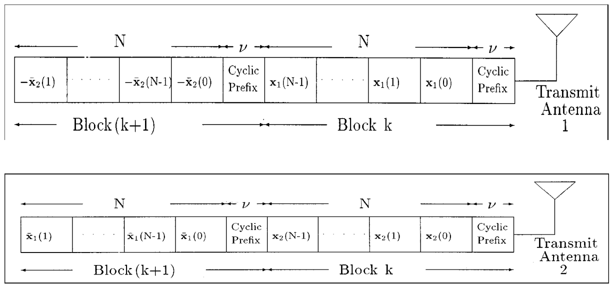
3. Channel Model and Assumptions

Taking a block transmission over an additive- noise frequency-selective channel consider in fading domain with memory **N** of single-carrier. To eliminate interlock interference (IBI) Length of each block is **v** appended with a length **N**- cyclic prefix. In hybrid-domain equalization architecture is proposed for single carrier systems which are known as decision feedback equalizer for single carrier frequency domain equalization (SC-FDE-DFE), in which FD-LE is conducted as forward equalizer and time domain transverse filter is adopted as feedback equalization. It can be achieved by discarding the first **N** received symbols corresponding to the cyclic prefix. Now, out of every received (**N+v**) symbols, only **N** symbols are processed. The input–output relationship can be expressed in matrix form as follows:

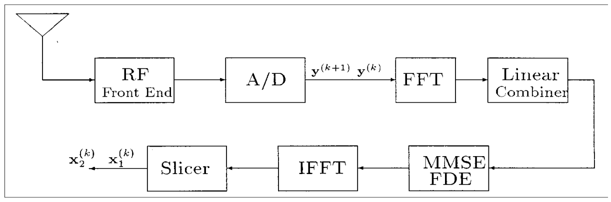
z=Su+t.

Where **z,u,t** are length-**X** blocks of received, input, and noise symbols, respectively. The **NxN** Channel matrix is circulate with first column equal to the channel impulse response (CIR) appended **(N-v-1)** by zeros. The input and noise symbols are assumed complex, zero-mean, and uncorrelated with variances. Based on the same principle, the structure of time domain noise predication decision feedback equalization is considered as the deformation of hybrid-domain equalizer. Introduces feedback filter and iterative design method into frequency domain. In the traditional SC-FDE-DFE is applied to SC-FDMA system for each single user.

Block format for proposed transmission scheme.



Receiver block diagram



4. Soft Decision Channel Estimation

Now we try to investigate a soft-decision-directed channel estimation (SDD-CE) algorithm that works in conjunction with the IFDE. Unlike conventional approaches for channel estimation, which rely on pilot symbols or hard decisions, the soft outputs of a turbo equalizer can be exploited to improve CE performance and combat error propagation. Mainly we consider a SDD time-domain CE (SDD-TDCE), which is the optimal estimator to minimize the MMSE under perfect model match assumption. However, the SDD-TDCE is computational intensive, thus not attractive for practical applications. Motivated by a significant reduction in complexity, we propose a two-stage channel estimator, the structure of which is depicted in the first stage, per-tone soft-input Kalman filtering is applied to track the channel in the frequency-domain. In the second stage, across- tone filtering is applied to refine the channel estimates. Finally, to handle the case where the channel statistics are unknown or time-varying, we propose a method to
Track the channel statistics inspired by soft decision on carrier transmission.

5. PROTOCOL AND SYSTEM MODEL OF THE D-SFBC SC-FDE

A. Protocol for D-SFBC SC-FDE

D-SFBC systems require two time slots for the transmission of one information block. The relay of source communicates with during the first time slot, while the destination does not receive direct signal from the source.

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Then, both the source and relay communicate with the destination in the second time slot to complete the transmission of SFBC signal. Future generation wireless systems will likely he required to provide data rates on the order of 50 to 100 **Mb/s.** For such high **data** rates, conventional time-domain equalization schemes are not practical, since the number of operations per symbol is proportional to IS1 (Inter-Symbol Interference) span. The channel impulse responses (CIRs) for the transmitting node A to receiving node B is given by $\mathbf{h}AB$ = [hAB(0), ..., hAB(LAB)]T , where LAB denotes the channel memory length. In this paper, subscripts S, R, and D stand for the source, relay, and destination nodes, respectively.

B. Source and relay structures for D-SFBC SC-FDE

The transmit sequence of the source (mobile equipment), **x**1 S, is equal to the information block **x** of length N, i.e., **x1S** = **x**. In the first time slot, the source transmits **x**1S after appending a cyclic prefix (CP) with length LSR, making the channel matrix circulate. At the relay, removing the CP, the received signal is given by **r**R = _ESR**H**SR**x**1 S + **n**R (1) where **n**R is a complex additive white Gaussian noise (AWGN) vector with each entry having a zero-mean and variance of N0. EAB represents the average energy available at the receiving node B, and **H**AB is an $N \times N$ circulate channel matrix with entries [HAB]k,l = hAB(($k-l$)N). (n)N represents n (mod N). Path loss and shadowing effects in $A \longrightarrow B$ link are included into EAB for simplicity. Fig. 2 shows a conceptual block diagram of the relay for D-SFBC SC-FDE. The received signal, **r**R, is normalized as ˜**r**R **r**$R/\sqrt{}ESR$+N0 to ensure unit average energy, and the discrete Fourier transform (DFT). FDE techniques have been shown to be suitable for high data rate transmission over severely time-dispersive channels, since the number of operations per symbol grows logarithmically with the IS1 span, thanks to the Fast Fourier Transform (FFT) implementation. Where **X**R is the transmit signal of the relay in frequency domain, and ˜**R**R = **W**˜**r**R. Changing the signs of the odd components and per mutating the even and odd components can be conducted by multiplying the following matrices, **S** and **P**, respectively.

Simulation Result:

We consider a frame-based transmission with 6 information blocks where each data block consists of 1024 QPSK modulated symbols. Np = 64, and 10 MHz bandwidth is used. All underlying links experience frequency-selective channels, where $S \longrightarrow R$ and $S \longrightarrow D$ links are modeled as six-tap TU channel and $R \longrightarrow D$ link is 2-path with a uniform delay power profile. We assume that the $S \longrightarrow D$ and $R \longrightarrow D$ links are balanced, i.e., perfect power control. Fig. 1 shows the performance of the proposed PPST for $E_b/N0$ = 10, and 20

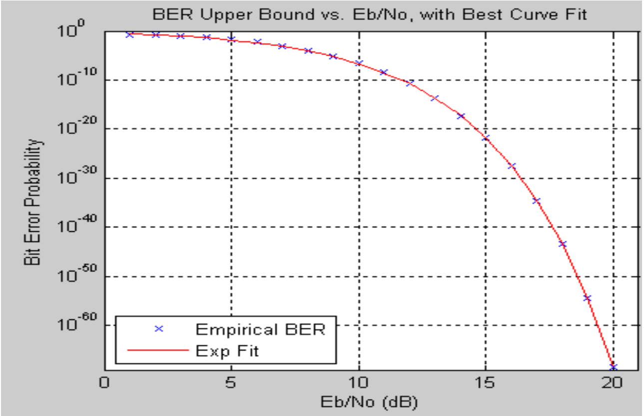
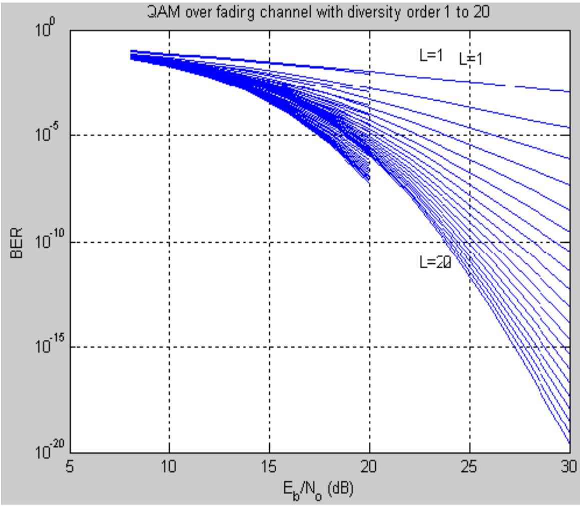


Fig. **2** shows the average BER performances for the parallel and successive receiver for different iterations. After the first iteration the performance of the parallel receiver **is** almost 2dB worse than the performance of the successive receiver. Afire iteration 3 this gap reduces to less than 1dB and after iteration
4 to 0.2 dB. Once again, the BER performances after four iterations are very close to the corresponding MFB for both structures. It should be mentioned that, for the parallel receiver, all layers have the same average BER.



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Conclusion:

A pilot position selection technique has been proposed for the channel estimation of D-SFBC SC-FDE transmission. We showed that the proposed pilot position selection, taking into account the impact of pilot positions on the time domain signals, minimizes the distortion of original signals. We also proposed two new iterative BLAST-based receivers for single carrier communication equipped with frequency-domain processing for joint cancellation of IS1 and Interference. Since frequency domain processing can be implemented efficiently by FFT operations, the proposed receivers are suitable for the high data rates of future wireless systems.

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