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Reduction of Co-Channel Interference in transmit/Receive diversity (TRD) in MIMO System

Manisha Rathore[1], Puspraj Tanwar[2]
Department of Electronic and Communication RITS,Bhopal[1,2]

Abstract

In this paper we proposed a novel technique for co-channel interference reduction for multiple input/multiple-output systems for channel fading with different diversity scheme. Our technique basically an adaptive variation of diversity scheme and reduced the ratio of outage probability of power of signal. Our analysis generalizes prior work in that we place no restrictions on the number or power of the interferers, or on the number of antennas at the transmitter and receiver. Our results indicate that, for adaptive interference power, system performance degrades when there are dominant interferers. In addition, for an adaptive of transmit and receive antennas, outage probability and average bit error rate decrease when the transmitter and receiver have the same number of antennas.

Keywords

MIMO, TRD, Co-Channel Interference, SNR

1. Introduction

Performance of wireless communication is challenging jobs in multiple-input/multiple-output system under different diversity scheme in presence of co-channel interference. All theoretical analysis for MIMO systems in the survey can be divided into two categories: Capacity analysis for the system efficiency [1][7] and performance analysis for the system reliability [8]. Although the capacity analysis and performance analysis focus on two different aspects of MIMO systems, both of them strongly rely on random matrix theory and matrix variety distributions. A MIMO system can be configured differently. One configuration is transmit/receive diversity (TRD) which has been widely used due to its simplicity and good performance. The TRD systems are a kind of wireless systems including traditional receive diversity as one of its special cases [8]–[10]. The performance of TRD systems depends on their operational environments without [11]–[12] or with [2]–[5] co-channel interferences, and the treatment is mainly focused on the classical Rayleigh or Rician fading channels. Diversity combining is a well-known technique to mitigate the performance degradation of multipath fading and co-channel interference (CCI) in wireless systems. Extensive analysis of transmitter or receiver diversity has been conducted over the last several decades to characterize the performance of different diversity-combining methods for different numbers of antennas and different fading distributions. [1,2,3] and the references therein). For a point-to-point communication link without CCI, it is well-known that maximal-ratio combining (MRC) is the combining technique in terms of maximizing the signal-to-noise power ratio (SNR) at the combined output. However, combining in the presence of CCI is much more complex than MRC and typically requires information about the CCI that may not be available [4][5]. Thus, in practice many wireless systems will use MRC even in the presence of CCI. the effect of co-channel interference (CCI) on the MIMO MRC systems was not addressed. However, it is well known that the MRC scheme is optimum (in the sense that it maximizes the output SNR) only in the absence of CCI. In practice, due to its relative simplicity compared to the more complex combining schemes that take into account CCI [7], [8], [9], [10], MRC will often be implemented and will end up operating in an environment rich in CCI. As such the effect of CCI is an important issue for a more realistic assessment of the performance of MIMO MRC systems.

Adaptive FFT arrays cannot simply be integrated into any arbitrary communication system, since a control process has to be implemented which exploits some property of the wanted, or interfering, signals. In general, adaptive FFTs adjust their directional beam patterns so as to maximize the signal-to-noise ratio at the output of the receiver. Applications have included the development of receiving systems for acquiring desired signals in the presence of strong interference, a technique known as reduction In this paper, we propose implement and simulate our proposed technique and compare the result in OFDM system.
The rest of paper is organized as follows. In Section 2, the system model for MIMO, Space-Time Block Codes and Space-Time Block Encoder is presented.

The Section 3 covers the Adaptive model. In section 4 discuss Rayleigh model. Section 5 present the comparison of the result SNR and BER gives the simulation results followed by a conclusion in Section 6.

2. System Model

Let us consider user employs r antenna to receive signal transmitted from t antenna. The channels that link the t transmit and r receive antennas are characterized by an r*t matrix , which is assumed to follow the joint complex Gaussian distribution with mean matrix M and covariance matrix ∑®Ψ[1] .
Symbolically, we will write

$H \sim CN_{r,t(M,} \sum ® \Psi)$……………………….(1)

Where Ψ and ∑ define the correlation structure at the transmit and receive ends, respectively. It is assumed that the intended signal is corrupted by l independent interferers, and the ith interferer transmits its signal with antennas. The desired information symbol b_o is weighted by the transmit beam former before being feeded to the transmit antennas. The transmit beam former is normalized to have a unit norm so that the transmit energy equals[3,4] . The vector at the desired user's receiver can, thus, be written as

$Y=b_{0Hu+\sum Hisi+n}$ …………………(2)

Where Hi is the r^*t_i the channel matrix characterizing the links from the desired user's r receive antennas to the ti transmit antennas of interferer i ; and is the symbols transmitted by interferer , such that $E[S_i S_j]$ with denoting the average symbol energy and E[.] denoting expectation. In the way similar to defining H , we assume

$H_{i\sim}CN_{r,ti}(M_{i,}\sum_{I\ (*)}\Psi_i$……………………………(3)

We assume the additive noise vector n to follow the r*1 complex Gaussian distribution of mean zero and covariance matrix R_n. conditioned on $H_{i,}$i=1,…………………l the covariance matrix of interference pluse-noise component is given by

$$\mathbf{R}_c = \sum_{i=1}^{\ell} E_i \mathbf{H}_i \mathbf{H}_i^{\dagger} + \mathbf{R}_n. \quad ……..(4)$$

Now we take a closer look at the correlation structure of H and H_i in (2). The correlations of the matrices H and H_i are specified ∑®Ψ by and $\sum_i$®Ψi, respectively. Physically, ∑and $\sum_I$ represent the correlation matrices of incoming signal and interference at the receiver, respectively. Correspondingly, the transmit-antenna correlations for the desired user are characterized by the correlation matrix, whereas its counterpart for interferer is specified by the correlation matrix. The structure of these correlation matrices depends on channel's fading characteristics, geometry and polarization of antenna arrays, and signal/interferers angle of arrival and spread.

3. Adaptive Model

Multiple diversity adaptive FFT arrays have been considered for enhancing the number of simultaneous users accessing networks. It is suggested that each user is tracked in azimuth by a narrow signal for both user-to-receiver and receiver-to-user transmissions. The directive nature of the signal ensures that in a given system the mean interference power experienced by any one user, due to other active users, would be much less than that experienced using conventional wide coverage receiver-station FFTs. It has already been stressed that high capacity cellular networks are designed to be interference limited, so the adaptive FFT would considerably increase the potential user capacity. This increase in system capacity of the new receiver-transmitter FFT architecture of an FFT array [16]. The results show that this type of recicver-transmeter FFT could increase the spectral efficiency of the network by a factor of 30 or more. These results were obtained for a hypothetical fast frequency hopping code division multiple network, assuming uniform user distribution and complete frequency reuse for the omnidirectional FFT case, i.e., adjacent cells are co-channel cells. Complete frequency reuse is then assumed for each of the signal formed by the adaptive array, i.e., adjacent beams are co-channel. Further, it was shown that a similar enhancement of efficiency can be obtained for either an idealized multi signal FFT.

At the receiver the signal vector from m^{th} receive antenna is given by Where $N_m(k)$ is complex gaussian noise vector with zero mean and equal variance for each receive antenna elements. $S_f(k)$ is original transmitted signal and $H_{m,f}$ is the channel matrix coefficients. We can collect M receive signal vectors and form an NxM receive signal matrix as

$R(k) = R_0(k)\ R_1(k)$ …………$R_{M-1}(k)$……………(5)

To reduce the noise among different subcarriers for FFT in balanced STTC the optimization will be $p_n = w^H h_n h_n^H w$ …………………………………… *(6)*
This equation represents the signal power of the n^{th} subcarrier after diversity combining.

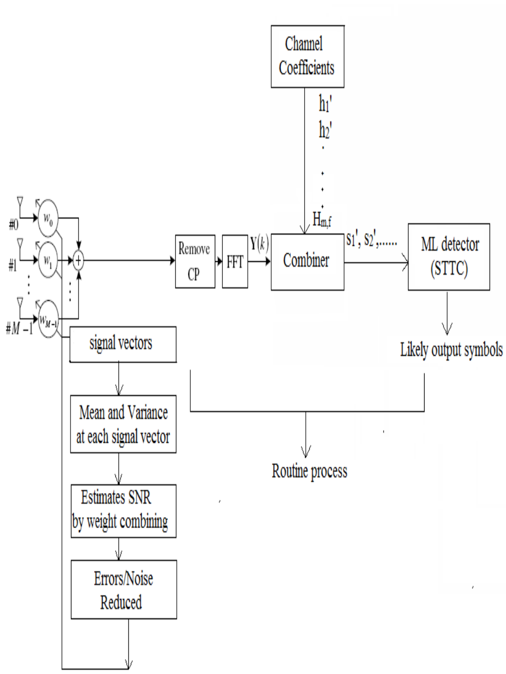

Figure 1: shows that model of FFT adaptive.

The idea behind these criteria is to optimize the SNR performance of worst subcarrier. The SNR from diversity combining will be
$\gamma = P_n / w^H R_n w$
Where p_n is the power of n^{th} subcarrier, w is the weight coefficient and R_n is the noise element The optimum value of w will be the eigenvector corresponding to the maximum eigenvalue of channel matrix. For optimum value of SNR $w^H w$ should be minimum subject to $w^H w = 1$

4. Rayleigh and Rician fading

We briefly introduced the concepts of signal scattering and multipath. Because the combined effect of the scattered signals cannot easily be expressed in closed form, more tractable statistical descriptions for the resulting fading coefficients have been derived based on the nature of signal propagation in the wireless environment [14]. As there are a large number of scatters in the wireless channel, the central limit theorem may be applied to obtain a limiting probability distribution for the composite received signal. Therefore, if there is no Line Of Sight (LOS) path from the transmitter to the receiver, we expect the real and imaginary parts of the complex baseband channel coefficients to be zero-mean Gaussian processes. Their magnitudes can then be modeled according to a Rayleigh probability distribution and their phases are uniformly distributed over $(0;2\pi)$. The propagation environment for any wireless channel in either indoor or outdoor may be subject to LOS (Line-of Sight) or NLOS (Non-Line-of-Sight). As described in the previous subsection, a probability density function of the signal received in the LOS environment follows the Rician distribution, while that in the NLOS environment follows the Rayleigh distribution. Any received signal in the propagation environment for a wireless channel can be considered as the sum of the received signals from an infinite number of scatters. By the central limit theorem, the received signal can be represented by a Gaussian random variable. In other words, a wireless channel subject to the fading environments can be represented by a complex Gaussian random variable, $W_1 + jW_2$, where W_1 and W_2 are the independent and identically-distributed (i.i.d.) Gaussian random variables with a zero mean and variance of σ^2 [5.10].

Let X denote the amplitude of the complex Gaussian random variable $W_1 + jW_2$, such that,
$X = \sqrt{(W_1^2 + W_2^2)}$
Then, X is a Rayleigh random variable with the following probability density function (PDF):

$$f_X(x) = \frac{x}{\sigma^2} e^{-\frac{x^2}{2\sigma^2}} \quad \text{............(7)}$$

Where $2\sigma^2 = E\{X^2\}$. Furthermore, X^2 is known as a chi-square (χ^2) random variable.

In some cases, particularly in some existing commercial fixed wireless systems, there is a LOS path from the base station to the subscriber units. The appropriate statistical model in this case is known as the Rice distribution. Its probability density function is given by

$$f(\alpha) = \begin{cases} \frac{\alpha}{\sigma^2} e^{-\frac{\alpha^2 + A^2}{2\sigma^2}} I_0\left(\frac{A\alpha}{\sigma^2}\right), & \alpha \geq 0 \\ 0, & \alpha < 0 \end{cases}$$

Where A is the peak amplitude of the dominant signal and $I_0(.)$ is the zeroth modified Bessel function of the first kind. The Ricean channel is sometimes described using the *K-factor* $K = \frac{A^2}{2\sigma^2}$, which is the ratio of the power of the dominant signal, or specular component, to that of the scattered signals, or Rayleigh component. Observe that when K = 0 the Ricean distribution becomes the Rayleigh distribution.

5. Simulation Results

In this section, we compare the performance of the adaptive technique with the orthogonal frequency division multiplexing (OFDM) systems. The key idea of adaptive is to employ the reduction of co-channel interference. Adaptive OFDM aims at providing either BER performance enhancement or power-efficiency improvement over conventional OFDM by incorporating different power allocation policies. Here give a parameter table for simulation. Here we demonstrate the result of outage probability and SIR.

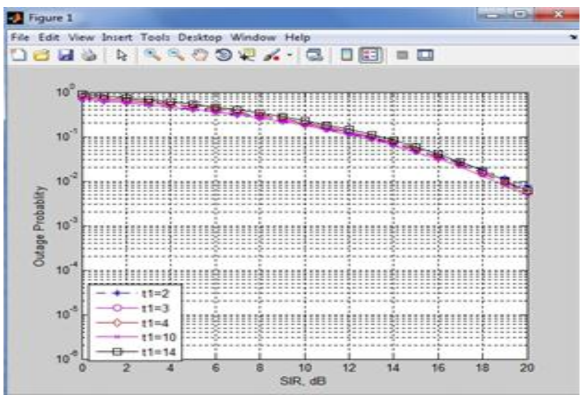

Figure 2: Variation of outage probability with the number of interfering antennas

Table 1: Modulation Scheme

Modulation scheme	BPSK
Number of subcarrier for OFDM	124
Symbol length	64
Channel state estimation	Perfect
Signal estimation	Correlated
Channel	Rayleigh fading channel

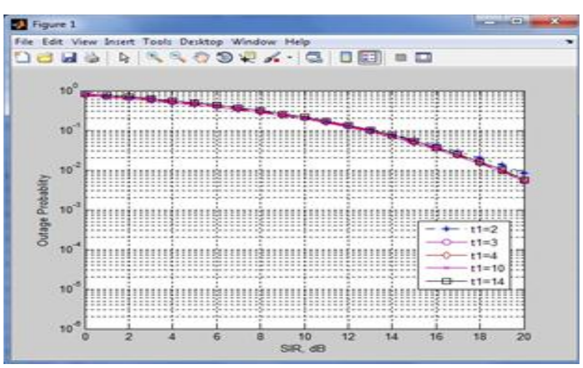

Figure 3: Influence of interference correlation on the outage performance

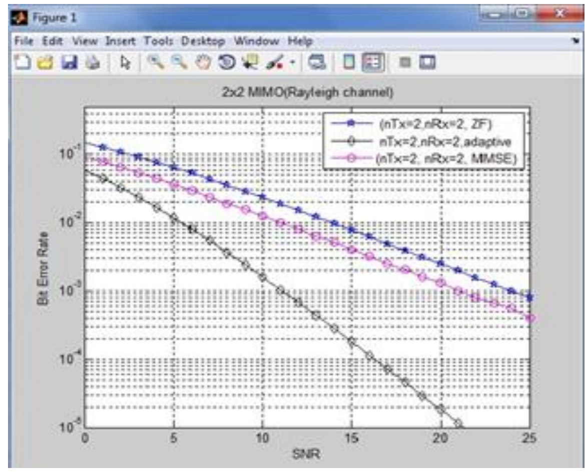

Figure 4: Improvement of performance of code in compression of exiting method and improve the gain ratio of MIMO system

6. Conclusion

In this paper we proposed a novel technique for reduction of co-channel interference and improve the utility of transmit/receive diversity in presence of channel fading. Our method reduced co-channel interference and improves the performance of MIMO system. Our simulation result shows the better performance in compassion of MRC and ICI.

Interferers cause the most degradation to system performance. This may follow from the fact that a single high-power interferer has more variation and therefore more impact on BER than a sum of many lower-power interferers. This result indicates that reducing the effects of dominant out-of-cell interference can significantly enhance performance in cellular systems.

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I am **Manisha Rathore** Pursuing M.Tech (Digital Communication.) from RITS, Bhopal (India). My research area is wireless communication and OFDM.