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Research Article

The Analysis of MIMO/OFDM Networks with group-selected Arrays signal Processing

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Abstract

Orthogonal frequency division multiplexing (OFDM) is a multi-carrier block modulation scheme suitable for wireless communication. OFDM has attracted a lot attention in broadband wireless systems. The use of group selected Adaptive arrays signals processing technology at both transmitter and receiver i.e. MIMO system, with OFDM can be combined to further improve the system performance. But they are relatively characterized by higher implementation complexity than simple selection diversity. It is the simplest way to realize MIMO/OFDM system but the performance improvement of this form of diversity is limited. In MIMO/OFDM system, the CSI is an important factor to impact the system capacity and should be small to improve the system efficiency. In this paper, the two techniques spatial diversity and group selected arrays signal processing are combined for MIMO/OFDM system with imperfect CSI and simulation result shows that system has significant performance improvements over the conventional array based OFDM system over frequency selective multipath fading channels.

Keywords: *Channel state information (CSI); MIMO/OFDM; group selected arrays*

1. Introduction

The future wireless broad communication networks are expected to have high quality, high data rate, and high capacity over radio channels. Multiple-input multiple-output (MIMO) modern signal processing technology provides significant increases in a system capacity and QoS as well as bandwidth efficiency in improvement in broad wireless networks through the use of spatio-temporal parallel signal processing at both the transmitter and receiver. However, multiple RF channel chains connected to multiple antennas are usually more expensive and complex than antennas arrays themselves. For the purpose of reducing the expensive and complex system realization, selection signal processing technique for MIMO systems is the simplest way to realize spatial signal processing, but the system performance is limited. MIMO systems based on the adaptive arrays signal processing and based on space-time coding signal processing can both provide significant increases in system performance, but they are both characterized by a relatively higher implementation complexity than selection signal processing. In this paper, we evaluate the performance of MIMO systems based on selective arrays signal processing and space-time block coding signal processing and give the comparison of their performance under perfect channel side information (CSI) available at both the transmitter and receiver sides. By evaluating their performance, we can see that selective adaptive arrays signal processing outperforms always selective space-time coding signal processing when imperfect CSI is available at both the transmitter and receiver.

We organize the rest of this paper as follows. Section 2 describes the system model of above mentioned selective spatial signal processing for MIMO systems. In Section 3 evaluates the performance of these systems. Finally, our conclusion is presented in Section 4.

2. MIMO/OFDM System Model Group Selection Array Signal Processing

The communication system model is plotted in Fig. 1. Communication system side at transmitter is equipped with *M* transmitting antenna arrays and communication system side at receiver is equipped with *K* receiving antenna arrays. The *N* signal symbols input **d** =[*d(0), d(1),d(2),* *d*(*N* -1)] is converted into parallel signal symbols. Group-selected arrays signal processing for each sub-carrier is performed with antenna arrays group selected from *N P M* antenna arrays according to arrays group selection criterion. The inverse fast Fourier transforms (IFFT) transforms the group-selected signal symbols into the time domain samples. Communication system sides at receiver, out of antenna arrays are group-selected.Then, the group-selected signals are transformed back into the frequency domain with an FFT. Finally, the

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signal symbol data originating from the group-selected transmitting antenna arrays is combined to form the arrays of output signals *i* th $\mathbf{d}\hat{} = [d\hat{}(0), d\hat{}(1), d(2) \ldots . d\hat{}(N-1)]$.

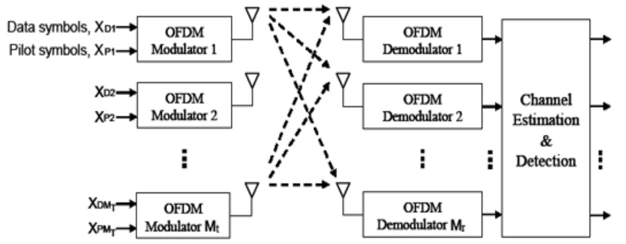

Figure1: MIMO/OFDM system model with Adaptive group selection arrays signal processing.

Assume the wireless communication networks channel between and the antenna array at the transmitter and receiver, respectively, to be characterized by a multipath fading channel. Let the $\mathbf{H}(i)$ denote M x K discrete time MIMO/OFDM channel matrix on the i subcarrier, Then weighting coefficient vector and receiving antenna arrays weighting coefficient vector for the sub-carrier as and , respectively. Then, the received signal, , for sub-carrier can be written as

$$H(i) = \begin{bmatrix} H_{1,1}(i) & \cdots & H_{1,k}(i) \\ \vdots & \ddots & \vdots \\ H_{M,1}(i) & \cdots & H_{M,K}(i) \end{bmatrix}$$

$$\hat{d}(i) = \left(S_r(i)\right)^H \left(H_S(i)\right)^T S_t(i) d(i) + \left(S_r(i)\right)^H N(i)$$

where the superscript H denotes the Hermitian operation, the superscript T denotes the transpose operation, is a Qx1 column vector with the arrays modeled as complex AWGN model with variance σ_n^2 is the P x Q group-selected sub-channel matrix out of $\mathbf{H}_s(i)$ M x K channel matrix $H(i)$ and can be rewritten as follows

$$H_S(i) = \begin{bmatrix} H_{1,1}^s(i) & \cdots & H_{1,Q}^s(i) \\ \vdots & \ddots & \vdots \\ H_{P,1}^s(1) & \cdots & H_{P,Q}^s(i) \end{bmatrix}$$

Then the maximal instantaneous receiving SNR for the *i*th sub-carrier signal processing can be written as

$$\left(\boldsymbol{SNR_s(i)}\right)_{max} = \frac{\mathrm{E}(|\mathrm{d(i)}|^2)\lambda_{max}\left[\left(H_s(i)\right)^*\left(H_s(i)\right)^T\right]}{\sigma_n^2}$$

Where $\lambda_{max}[A]$are the largest eigen value of the matrix A. The objective of group selected antenna arrays at both the transmitter and receiver sides for grouping is to maximize the average SNR. Therefore, the optimal group selected sub-channel matrix H_s (i) on the ith sub-carrier should maximize the largest eigen value of channel matrix $(H_s(i))^* \ (H_s(i))^T$.

3. Performance Simulation Results and Discussion

In this section simulation results are provided for the proposed MIMO/OFDM system under imperfect CSI using two group selected adaptive antennas arrays (P=2) from different antenna configurations at the transmitter and two group selected adaptive antenna arrays (Q=2) from three adaptive antenna arrays (L=3) at receiver.

Data symbol mapping in MIMO/OFDM system is QPSK for 128 subcarriers with different antenna arrays. Here one OFDM symbol of 148 µs comprised of one OFDM data symbol of 128 µs and cyclic prefix durations of 20 µs are used. Simulation is done over typical-urban (TU), frequency-selective Rayleigh fading channels and RMS delay spread of the 6-ray channels is 1µs.

Fig. 2 shows that that the proposed group-selected transmitting and receiving antenna arrays based OFDM systems reaches significant gains over the conventional adaptive antenna arrays based ones over multipath fading channels. The results shows that as the number of transmitted antenna increases the bit error rate also decreases .As shown in figure 2 that for (4Tx,3Rx)bit error rate is decreased if compared with (3Tx, 3Rx).

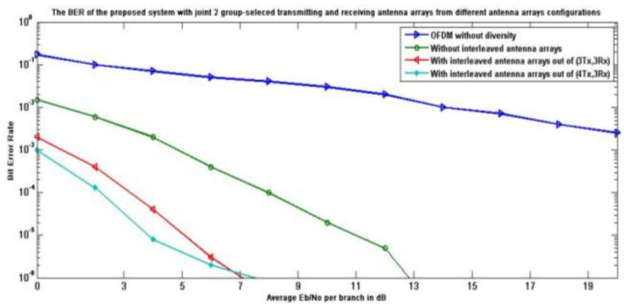

Figure 2: BER of the proposed system with join 2 group selected transmitting and receiving antenna arrays from different antenna arrays.

In fig. 3 BER curves for various MSE values for the conventional adaptive antenna arrays based OFDM system without group-selecting with the same configuration are shown and observed that the proposed system for a MSE of –20dB in channel estimation errors has a performance that is almost as good as the one with perfect channel information and noted that as the MSE increases the performance of the proposed system degrades.

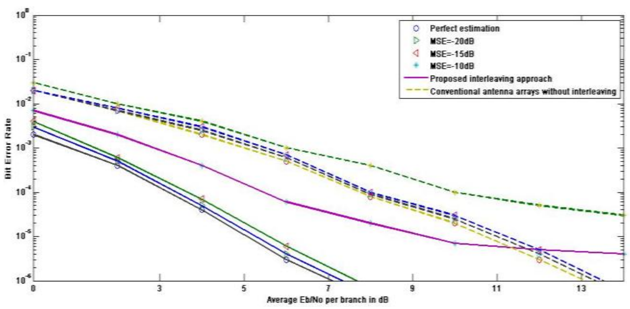

Figure 3: Effect of channel estimation errors on BER performance with join 2 group selected transmitting and receiving antenna arrays from different antenna arrays.

In fig. 4 result indicates that the proposed approach outperforms the conventional adaptive antenna array based OFDM system and observed that the proposed approach reaches significant gains over conventional scheme without group selecting under imperfect channel, state information.

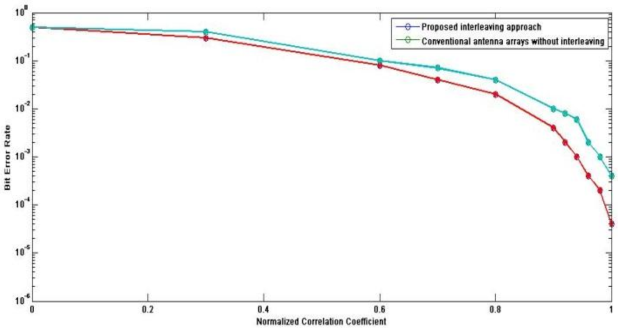

Figure 4: Effect of imperfect CSI on BER performance with join 2 group selected transmitting and receiving antenna arrays from different antenna arrays.

4. Conclusion

Adaptive antenna arrays can achieve significant increases in a system's capacity and bandwidth the efficiency as well as in QoS improvement in wireless communications, but they are characterized by a relatively higher implementation complexity. Selection diversity is the simplest way to realize such MIMO/OFDM systems, but the performance improvement of this form of diversity is limited .In this paper, a group-selected antenna arrays signal processing technology is proposed for MIMO/OFDM communication systems. The proposed system can reduce the implemental complexity of developing MIMO/OFDM systems in practice while still having benefits of multiple antenna arrays at both the transmitting and receiving sides. Performance simulation results shows that the proposed group-selected antenna arrays communication system can reach significant performance improvements over the conventional adaptive antenna array based OFDM systems without group-selecting over multi-path fading channels under imperfect channel information.

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