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Proposed Adaptive Multiuser Detection for Estimation of Orthogonal Frequency Division Multiplexing

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ABSTRACT

Based on analysis of technical principal high data rates, better quality of service and higher network capacity is required by many applications. The combination of MIMO with OFDM is a solution to achieve above objectives for next generation network operating in frequency selective fading environment. In AMUD MIMO-OFDM, the channel gain of the pilot-added subcarrier is first estimated by simply coherently multiplying the pilot symbol by its received signal. Since pilot symbols for each signal stream are added to every subcarrier at each time domain pilot slot, channel gains of other non-pilot-added subcarriers are estimated by using linear interpolation. Finally, the channel gain at each subcarrier is estimated by averaging over the OFDM pilot slots. AWGN power is estimated by averaging the residual power of the signal obtained by subtracting the received pilot signal replica formed by using the estimated channel from the received signal. AMUD MIMO-OFDM performs better when compared to SISO-OFDM and MIMO-OFDM in terms BER AND SNR.

Keywords: AMUD, BER, MIMO, OFDM, SNR

1. INTRODUCTION

The adaptive Multiuser detection is the preferred detection technique in this paper because it sends in training signals to monitor the parameters of the channel and adjusts the parameters of its filter to suit the desired signals. The effect, importance and advantages of the fundamentals will facilitate and make it possible for the aims of this research work to be achieved thus it is the foundation in which we explore our research. Multiuser Detection provides the first comprehensive treatment of the subject of multiuser digital communications. Multiuser detection deals with demodulation of the mutually interfering digital streams of information that occur in areas such as wireless communications, high-speed data transmission, satellite communication, digital television, and magnetic recording. The development of multiuser detection techniques is one of the most important recent advances in communications technology. There are various detection technique to be discussed in this chapter.

Adaptive MMSE Multiuser detection (A MMSE MUD) is for demodulation of digitally modulated signals with multiple access interferences (MAI). This scheme was designed for total elimination of MAI in the system. In a single user environment, every match filter maximum likelihood receiver plays the role of Adaptive MMSE maximum likelihood receiver .

In the implementation of Adaptive Minimum Mean Square Error Multiuser Detection (A MMSE MUD), it provides robustness and mobility in a time variable frequency selective multipath fading channel; it improves the bit error rate performance and therefore enhances channel capacity of a multi-cellular environment. MIMO OFDM mitigates multiple access interference and increases capacity .In A MMSE MUD techniques was used effectively to achieve the performance of a maximum likelihood estimator but on a linear complexity.

2. GENERAL SYSTEM MODEL FOR AMUD MIMO-OFDM

The system has N_t transmit and N_r receive antennas and k sub-carrier in one OFDM block as shown in Fig 1. The channel between each pair of the N_t and N_r antennas are uncorrelated to each other. At time n, during transmission interval, a stream of binary bits b is coded into the N_t antenna symbol blocks. The signal on the k^{th} sub-carrier at the ith antenna is denoted by $x_i[n, k]$, where $i = 1,...N_t$, $k = 0, ..., ..., K - 1$, $n = 0, ..., N - 1$. Though the Fig shows MIMO OFDM with four transmit antennas, the scheme developed in this thesis can be directly applied to OFDM systems with any number of transmit antennas. The received signal N_r antenna j is:

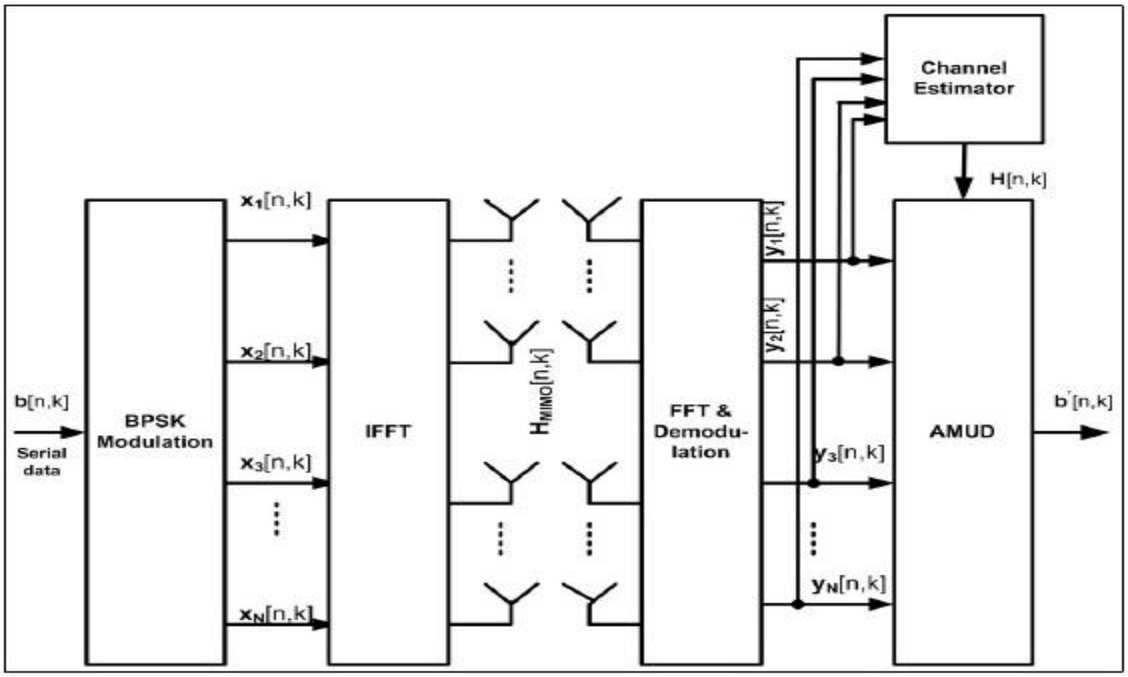

Fig 1: General System Model for AMUD MIMO OFDM

1.b[n, k]=block of OFDM symbols
2. x[n, k]=Transmit vectors
3. H_{MIMO} = MIMO channel
4. y[n, k] = Received symbols
5. b [n, k] = Output symbols

$$N_t\, y_j [n, k] = H_{ij} [n, k] x_N [n, k] + n_j [n, k] \quad ....(4.6)$$

where H_{ij} [n, k] is the channel frequency response between antennas i and j, n_j [n, k] is the additive gaussian noise with zero mean and variance σ_n . The above equation can be written as:

$$y_j [n, k] = H_{ij} [n, k] x_N [n, k] + n_j [n, k] \text{ ....} \quad (4.7)$$

The equations above (3.15 and 3.16) were further developed as:

The equations above were further developed as:

$$y_j [n, k] = H_{ij} [n, k] x_i [n, k] + n_j [n, k] \quad \text{........................} \quad (4.8)$$

Where $H_{i,j}$ [n, k] indicates the channel frequency response from transmitter i to receiver j at the k^{th} tone of the OFDM block at time n and noise n_j [n, k] is assumed to be zero-mean with variance σ_n and uncorrelated for different n s, k s or j s, H_{ij} [n, k] denotes the channel frequency response for the k^{th} tone at time n, corresponding to i^{th} transmit and j^{th} receive antenna. The statistical characteristics of wireless channels are briefly described in this thesis. The receiver first must estimate and correct for frequency offset and the symbol timing, e.g., by using the training symbols in the preamble. Subsequently, fast Fourier transformation (FFT) is performed per receiver branch. Spreading is done to increase resistance to natural interference and jamming that may prevent detection. AMUD detection was employed per OFDM subcarrier to recover the data signals transmitted on that subcarrier. The symbols per transmit stream are combined, and finally detection is performed for the parallel streams and the resulting data are combined to obtain the signal.

3. MIMO-OFDM CHANNEL CAPACITY

MIMO systems consist of transmit and receive antennas. It is considered a network with transmission paths connecting each input to output. The MIMO OFDM system capacity is:

$C = \log_2[1 + (p/n)\lambda_{est}]$ b/s/Hz…………… (1)

Where C is the system capacity, H is complex transpose channel correlation matrix whose components are given by equation (3.25), transmitter i to receiver j at the kth tone of the OFDM. The capacity formula for the MIMO OFDM is further developed as:

$C=E \log(1 + p /n)\lambda_{est}$ b/s/Hz …………….. (2)

Where λest is the complex transpose and E is an estimation of the capacity. p/n is SNR. Thus the capacity formula for MIMO OFDM is as shown below and the simulation result of channel capacity in Fig 4.4 based on the assumption that the channel matrix which consists of independent and identically distributed iid Rayleigh fading coefficients shows that the developed technology sum rate capacity in Fig 4.4.

$C = \log_2 (1 +p /n)\lambda_{est}$ b/s/Hz ………..................(3)

Thus the MIMO OFDM capacity formula is as shown below and the simulation of channel capacity based on the assumption that the channel matrix which consists of independent and identically distributed iid, Rayleigh fading coefficients predicts that the developed technology system capacity is very close to the MIMO theoretical upper bound.

$C = \log_2 (1 +p/n)\lambda est$ b/s/Hz .... 4)

CONCLUSION

The MIMO-OFDM technology presented in this paper involves for use of AMUD which enhance system performance in wirelesscommunication system. . An adaptive MIMO-OFDM scheme with two-dimensional channel state estimator is designed and implemented in this work. The critical performance measures of practical interest are evaluated for study. The modulation schemes applied to each subcarrier is independently optimized in this work, and as a result the spectral efficiency is maximized, without any tradeoff in the target Bit Error Rate (BER). The results are demonstrated for a fading channel and improve in the Signal to Noise Ratio (SNR) required maintaining a BER, as compared with other fixed modulation schemes. Adaptive user allocation exploits the difference in frequency selective fading between users, to optimize user subcarrier allocation. In a multipath environment the fading experienced on each subcarrier varies from user to user, thus by utilizing user/subcarrier combinations that suffer the least fading, the overall performance is maximized.

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