SYNCHRONIZATION AND CHANNEL ESTIMATION IN HIGHER ORDER MIMO-OFDM SYSTEM

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Abstract - *An MIMO-OFDM system is suitable for high diversity gain between receiver and transmitter. So, channel estimation in the system is complex. To provide high diversity gain, the channel estimation method in multi-antenna systems is better performance than in one antenna system. The paper presents the channel estimation with zero forcing algorithms (ZF) in MIMO-OFDM systems. In this work, the channel estimation techniques based on pilot insertion between subcarrier. Therefore estimation of channel status is necessary frequency synchronously between receiver and transmitter. In this paper, to calculate the channel coefficients estimation and the frequency offset in MIMO-OFDM system. The Simulation results Shows that proved the better BER performance 4*4 of channel estimation algorithm than 2*1 and 2*2 MIMO-OFDM system.*

Key Words: Multi-Input Multi-Output systems, zero-forcing decoding, Channel estimation, Synchronization, MLE algorithm

1. INTRODUCTION

Wireless systems are expected to require high data rates with low delay and low bit-error-rate (BER). In such situations, the performance of wireless communication systems is mainly governed by the wireless channel environment. In addition, high data rate transmission and high mobility of transmitters and/or receivers usually result in frequency-selective and time-selective, i.e., doubly selective, fading channels for future mobile broadband wireless systems. Therefore, mitigating such doubly selective fading effects is critical for efficient data transmission. Moreover, perfect channel state information (CSI) is not available at the receiver. Thus in practice, accurate estimate of the CSI has a major impact on the whole system performance [1]. It is also because, in contrast to the typically static and predictable characteristics of a wired channel, the wireless channel is rather dynamic and unpredictable, which makes an exact analysis of the wireless communication system often difficult.

OFDM divides the available spectrum into a number of overlapping but orthogonal narrowband sub channels, and hence converts a frequency selective channel into a non-frequency selective channel [2]. Moreover, ISI is avoided by the use of CP, which is achieved by extending an OFDM symbol with some portion of its head or tail [3]. With these vital advantages, OFDM has been adopted by many wireless standards such as DAB, DVB, WLAN, and WMAN [5, 4]. For conventional coherent receivers, the effect of the channel on the transmitted signal must be estimated to recover the transmitted information [6]. As long as the receiver accurately estimates how the channel modifies the transmitted signal, it can recover the transmitted information.

Channel estimation can be avoided by using differential modulation techniques, however, such systems result in low data rate and there is a penalty for 3–4 dB SNR [7]. In some cases, channel estimation at user side can be avoided if the base station performs the channel estimation and sends a pre-distorted signal [8]. However, for fast varying channels, the pre-distorted signal might not bear the current channel distortion, causing system degradation. Hence, systems with a channel estimation block are needed for the future high data rate systems.

2. PROPOSED METHOD

2.1 Modulation

In an MIMO-OFDM system, the high information data is split into sub carriers and placed orthogonal to each other. This is achieved by modulating the data using modulation technique like QPSK and QAM. Apply the serial to parallel convertor to the modulation, the data is dividing to multiple data. After this, to remove the inter symbol interference (ISI) a cycle prefix is added to the data.

2.2 Demodulation:

In this case, demodulation is used to recover the received information accurately. It is vice versa of modulation.

2.3 4*4 symbol matrix

Four by four symbol matrix with one receiver and four transmitted antenna is consider. The 4×4 symbol matrix in proposed method is given by

$$X=\begin{bmatrix} s1 & s2 & s3 & s4 \\ -S2* & S1* & -S4* & S3* \\ -S3* & -S4* & S1* & S2* \\ S4 & -S3 & -S2 & S1 \end{bmatrix}$$

In the above matrix, each code block consists of 4 symbols, S1, S2, S3 and S_4. The symbols, S1, S2, S3, S4, are transmitted from antenna 1, 2, 3 and 4 during the first time slot. The negative complex conjugate of S2 ,complex conjugate of S1, complex conjugate of S1, complex conjugate of S1 are transmitted from antenna 1 ,2,3 and 4 during the fifth time slot.

The diversity gain defined by number of information symbols transmitted divided by number of time slots in a symbol matrix

The received signal of 4×4 symbol is given by

R=HX+n

Where

N= additive white Gaussian noise

H= channel matrix and is given by

$$H=\begin{bmatrix} h1 \\ h2 \\ h3 \\ h4 \end{bmatrix}$$

X= symbol matrix

R=received signal

2.4 2*2 symbol matrix

The 2*2 symbol matrix in proposed method is given by

$$X=\begin{bmatrix} s1 & s2 \\ -s2* & s1* \end{bmatrix}$$

In the above matrix, each code block consists of 2 symbols, S1and S_2. The symbols, S1, S2are transmitted from antenna 1 and 2 during the first time slot. The negative complex conjugate of S2, complex conjugate of S1, transmitted from antenna 1 and 2 during the 2nd time slot.

The received signal of 2*2 symbol is given by

R=HX+n

Where

N= additive white Gaussian noise

H= channel matrix and is given by

$$H=\begin{bmatrix} n1 \\ n2 \end{bmatrix}$$

X= symbol matrix

R=received signal

2.5 Zero force (ZF) decoder

It avoid the effect of ISI between subcarriers. In ZF decoding, a Ω matrix multiply with H is given by

HΩ=diag (Ø1, Ø2) +ΩZ

Where

Ø1, Ø2 are complex numbers.

Z=noise

3. CHANNEL ESTIMATION

In MIMO-OFDM systems can improve better quality signal and capacity. For the OFDM systems assign multiple channel parameters of each channel. Channel parameters of each channel based on correlation. In this paper, we use the sequence method as channel estimator for high diversity wireless data access. The channel estimation approach separating the N received signals, corresponding to N transmitted signals based on correlation at received signal in MIMO-OFDM system. The sequence method consists of different stages. The first stage separates transmit signals and find the channel response in the first dimension. The second stage separates the transmitted signals in second dimension and so on...

4. EXPERIMENTAL RESULTS

The proposed method can be implemented using MATLAB tool. The proposed 4*4 symbol matrix has better BER performance than 2*2 symbol matrix.

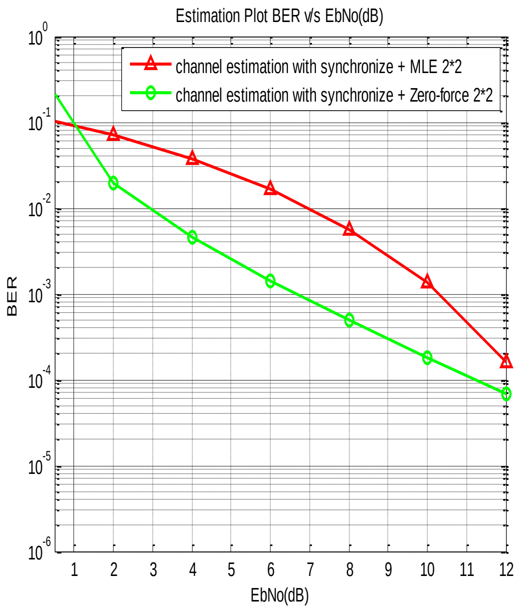

Chart -1: Channel estimation with synchronize with ML and ZERO force decoding in 2*2 MIMO-OFDM systems

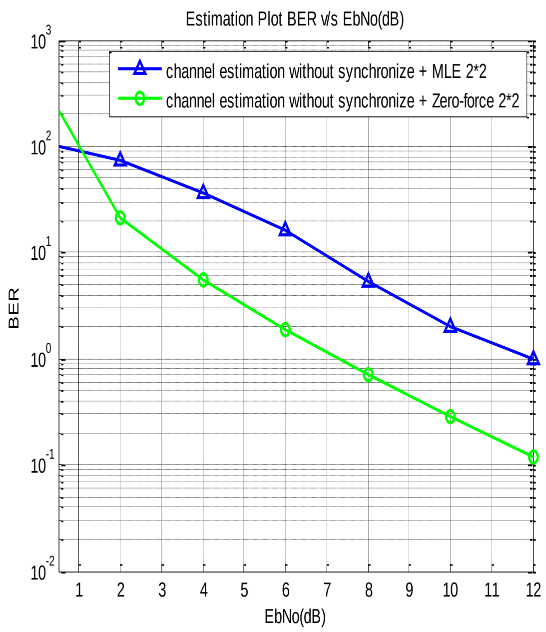

Chart -2: Channel estimation without synchronize with ML and ZERO force decoding in 2*2 MIMO-OFDM systems

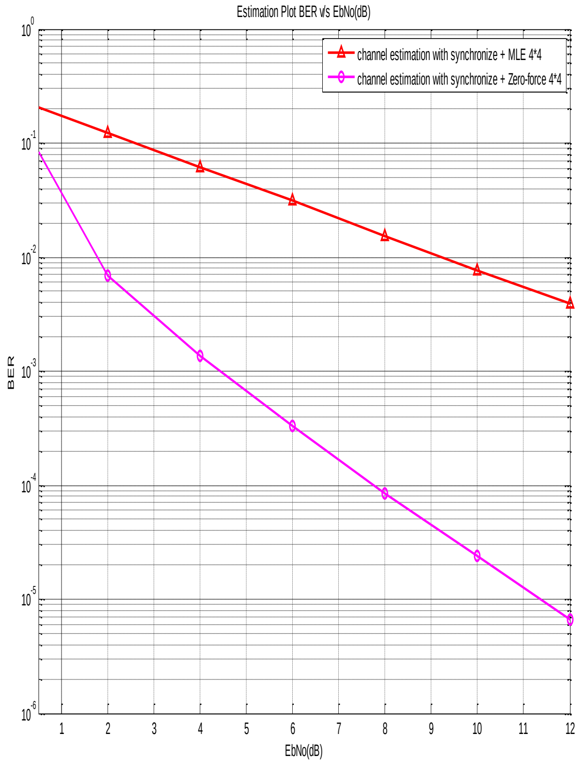

Chart -3: Channel estimation with synchronize with ML and ZERO force decoding in 4*4 MIMO-OFDM systems

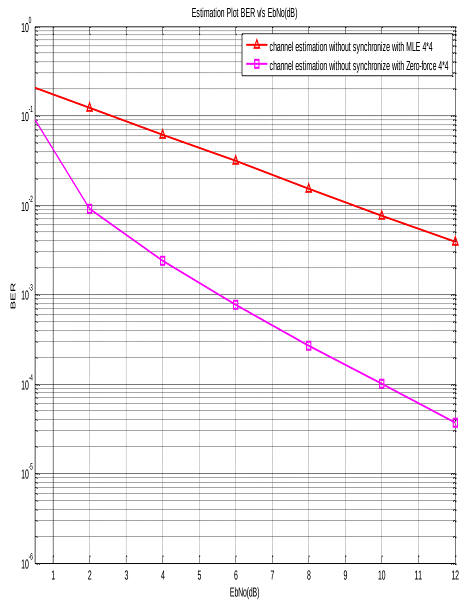

Chart -4: Channel estimation without synchronize with ML and ZERO force decoding in 4*4 MIMO-OFDM systems

Table-1: Channel Estimation for 2*2 MIMO-OFDM system with synchronization

SNR	WITH SYNCHRONIZATION 2*2	
	MLE	ZF
2	0.07102	0.01927
4	0.03656	0.004589
6	0.01652	0.001413
8	0.005547	0.0004857
10	0.001367	0.0001775
12	0.0001563	6.744e-005

Table-2: Channel Estimation for 2*2 MIMO-OFDM system without synchronization

SNR	WITHOUT SYNCHRONIZATION 2*2	
	MLE	ZF
2	72.5	21.17
4	35.75	5.546
6	16	1.878
8	5,25	0.7101
10	2	0.2854
12	1	0.1193

Table-3: Channel Estimation for 4*4 MIMO-OFDM system with synchronization

SNR	WITH SYNCHRONIZATION 4*4	
	MLE	ZF
2	0.07102	0.006865
4	0.03656	0.001352
6	0.01652	0.0003284
8	0.005547	8.697e-005
10	0.001367	2.438e-005
12	0.0001563	6.532e-005

Table-4: Channel Estimation for 4*4 MIMO-OFDM system without synchronization

SNR	WITHOUT SYNCHRONIZATION 4*4	
	MLE	ZF
2	72.5	9.342
4	35.75	2.452
6	16	0.7541
8	5,25	0.2703
10	2	0.1045
12	1	0.0378

5. CONCLUSION

In the work, the channel estimation of 2×2 and 4×4 MIMO-OFDM system. Comparison is done for both 2×2 and 4×4 for channel estimation and the results are observed and performances of channel estimators based on bit error rate. OFDM-based systems are generally used in time varying channel estimation. The Simulation results Shows that proved the better BER performance 4×4of channel estimation algorithm than 2×1 MIMO-OFDM system.

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BIOGRAPHIES

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