BER Analysis of 2×2 MIMO- OFDM using QPSK Modulation Schemes for different Number of Subcarriers and Pilot Spaces under Rayleigh Fading Channel with AWGN

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Abstract: This paper shows the performance analysis of 2×2 MIMO-OFDM using QPSK modulation scheme for different sub-carriers and pilot spaces under Rayleigh Fading Channel with AWGN. MIMO-OFDM is a combination of MIMO and OFDM technology. In this technology Orthogonal Frequency Division Multiplexing (OFDM) is used to improve spectral efficiency and Multiple Input Multiple Output (MIMO) is used to improve spatial diversity. This is a comparative analysis of obtained SNR for approximating ideal BER on different sub-carriers and pilot spaces. The result shows that BER improved dramatically in low SNR as increment in number of sub-carriers and decrement in pilot spaces.

Index Terms- MIMO, OFDM, IFFT, FFT, BER, SNR, AWGN, Rayleigh Fading

I. Introduction

In this paper due to the increased demand of spectral efficiency and spatial diversity we utilize the technique of MIMO-OFDM to enhance the technique by minimizing the BER. It is a broad band wireless communication technology. MIMO-OFDM is a combination of MIMO and OFDM technology. In MIMO-OFDM technology, Orthogonal Frequency Division Multiplexing (OFDM) is used to improve spectral efficiency and Multiple Input Multiple Output (MIMO) is used to improve spatial diversity [1]. During the last years MIMO-OFDM system has gained an increased interest in that topic. MIMO-OFDM (Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing) is a broad band wireless communication technology. It has great capability of high data rate transmission and its robustness against multipath fading and other channel impairments [2]. Its channel capacity has been increase linearly with the number of antennas at both ends [3]. The generation of multiple signals at the same time then we see that it drops us towards the signal interference, so whenever MIMO comes in forefront, it is comes with Orthogonal Frequency Division Multiplexing (OFDM) [4]. Both of these techniques MIMO and OFDM stand as promising choices for prospect high data rates. It shows robustness for multipath fading and interference.

II. Proposed Model

A general block diagram of a MIMO-OFDM system is shown in Fig.1.

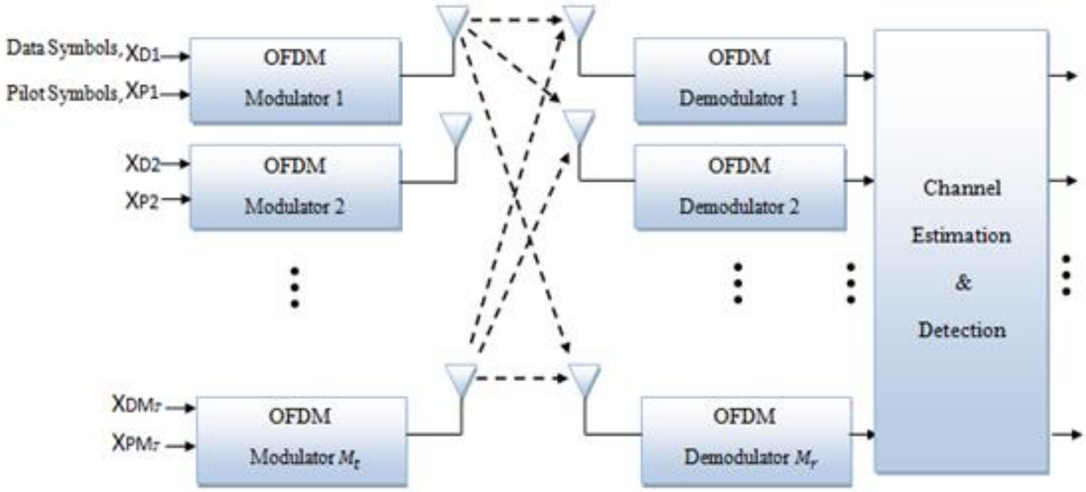


Fig.1.Block Diagram of MIMO-OFDM

In this project of MIMO-OFDM transmitter and receiver we have combined MIMO and OFDM. We have taken 2 transmitting antennas ($\mathrm{NT}_X = 2$) and 2 receiving antennas ($\mathrm{NR}_\mathrm{X} = 2$). OFDM signal is generated by choosing the spectrum required, based on the input data and after than the modulation scheme is used. Each carrier to be produced is assigned data to be transmitted. Then based on the modulation scheme the required amplitude and phase of the carrier is calculated. After then serially transmitted data is send to QAM modulator used to convert parallel signal. Then the pilot carrier insertion, we must have a fast way to create OFDM symbols. Hence IFFT is used. For the reduction of the ISI effect cyclic prefix is applied to the signal. It is an extra extension that is duplicated from the end of symbol and inserted at the front of the symbol. Then in terms of translating the frequency, up-conversion stage is used for converting the baseband OFDM signal to the desired band. Then the resulting data transmitted through channel. At receiver side the reverse process of transmitter side is have to be done that is serial to parallel converter, remove cyclic prefix, FFT, channel estimation, parallel to serial converter and at last symbol-demapping at which input-binary information is recovered that went through all these steps on both sides of the systems.

In this analysis we are used two performance parameters these are BER and SNR

1. **Bit Error Rate**: BER is basically the probability that bit is received in error. Its formula is the number of bit errors divided by the total number of transferred bits during a time interval. The mathematical formula for the BER is given as follows:

$$P_e=0.5(1-\sqrt{\frac{SNR}{SNR+2}})$$

2. Signal to noise ratio

It is defined as a ratio between signal power to noise power and it is normally expressed in decibel (db). It's mathematical expression as [4]:

$$\log 10 \frac{\text{signal power}}{\text{noise power}} \ (\text{db})$$

III. Simulation Results and Discussion

In this simulation we have transmitted nearly 1 Lac Symbols. Table 1 shows the input parameters for this simulation.

Table1

Setting of input parameters for simulation

Input Parameters	Value
Total Number of OFDM Symbol	1e2
Number of Transmit Antenna	2
Number of Receive Antenna	2
Number of Subcarriers	64/128/256
Cyclic Prefix Percentage	1/4
(Modulation Scheme) Modulation Order	(QPSK) 4
Between two pilots pilot space	1/2/4

The comparative simulation results for different number of subcarriers and pilot spaces basis on these three points.

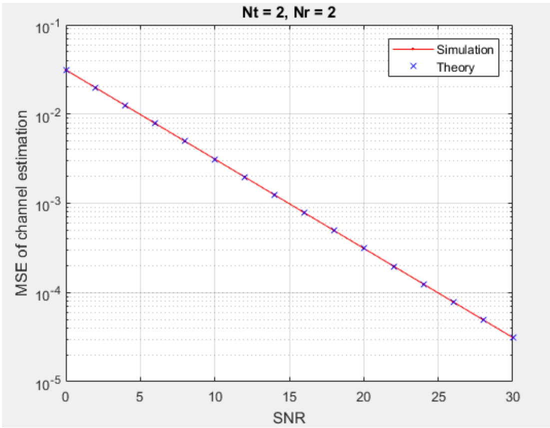
1 Comparative analysis of MSE channel estimation obtained for different number of subcarriers using particular pilot space.

2 Comparative analysis of obtained SNR for ideal BER for different pilot spaces at each used number of subcarriers.

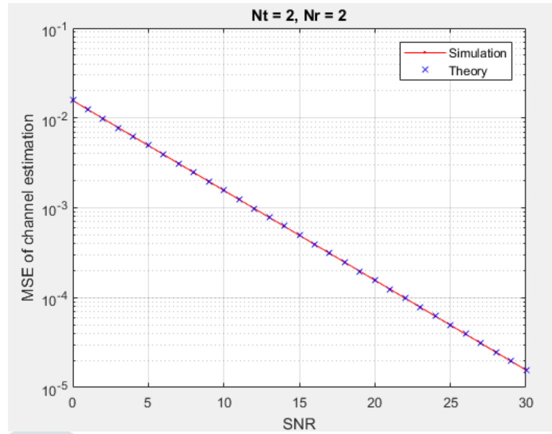
3 Comparative analysis of obtained SNR for ideal BER for different subcarriers using particular pilot space.

For obtaining a good signal in wireless communication system we have to take different channel estimation techniques as discussed in the theory of chapter 3. In this simulation MSE channel estimation technique is used.

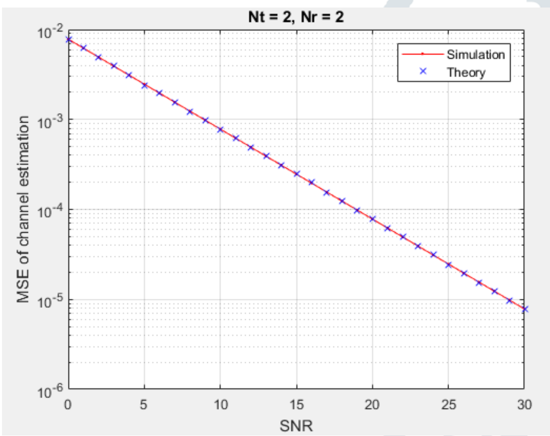
[1] Comparative Analysis of MSE channel estimation obtained for different Number of Subcarriers using particular Pilot Space.



(a) Number of sub-carrier (NS_1) =64



(b) Number of sub-carrier (NS_2) =128

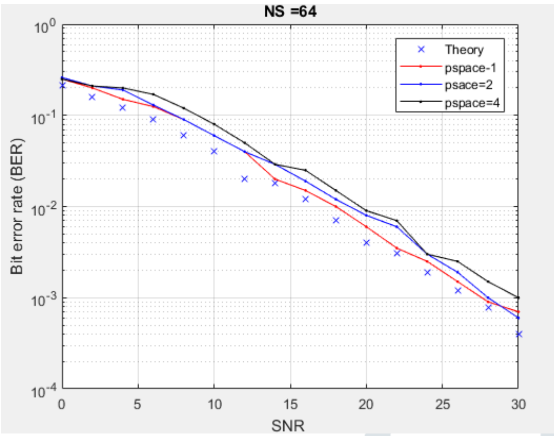


(c) Number of sub-carrier (NS_3) =256

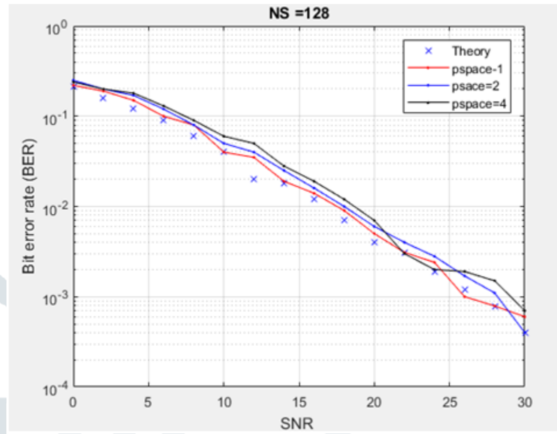
Fig.1. Simulation Results of MSE channel estimation technique for different Number of subcarriers at Pilot Space=1

[2] Comparative Analysis of BER for different Pilots Spaces at each used Number of Subcarriers

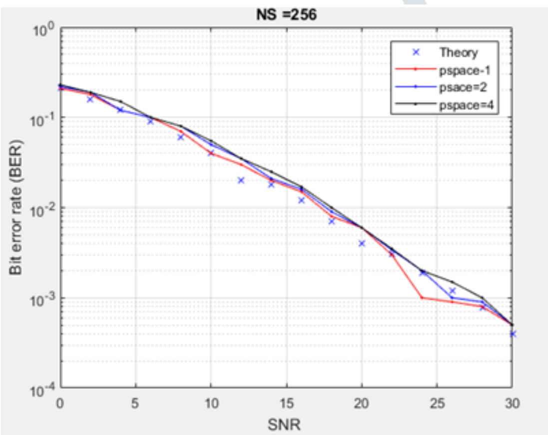
We have found that for a wireless signal as the no. of sub-carriers increases with using particular pilot space we got ideal BER at low SNR comparative to SNR for lower number of sub-carrier value. Simulation results for all used three subcarriers NS_1=64, NS_2=128, NS_3=256 for pilot spaces1, 2 and 4as shown in figures below:



(a) Number of Subcarriers=64



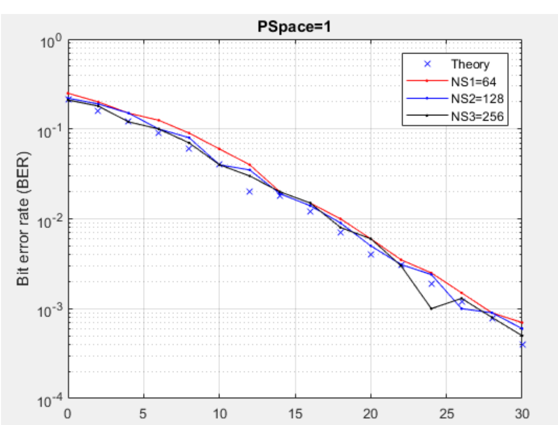
(b) Number of subcarriers=128



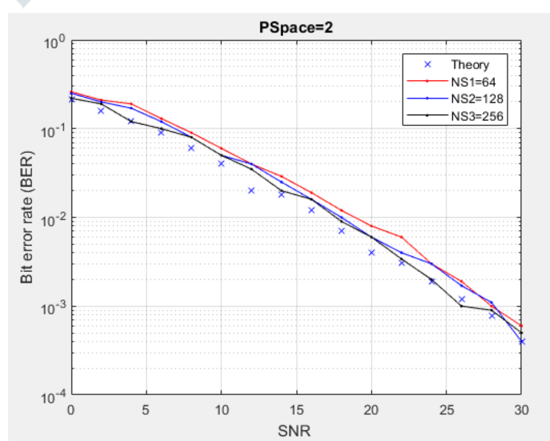
(c) Number of subcarriers=256

Fig.2. Simulation Results for ideal BER at Pilot space 1, 2 and 4 for different Number of subcarrier

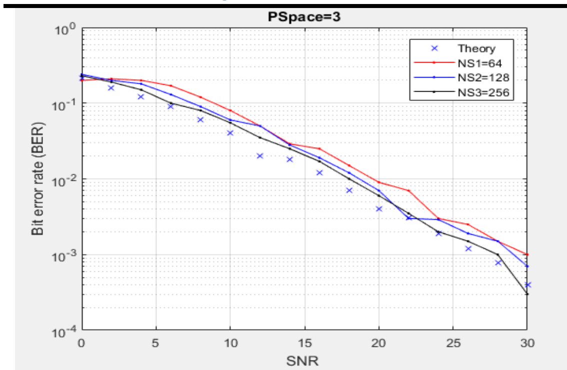
[3] Comparative Analysis of BER for different Number of Subcarriers using particular Pilot Space



(a) Pilot Space =1



(b) Pilot Space =2



(c) Pilot Space =3

Fig.3. Simulation results using particular pilot space for different number of subcarriers

IV. Conclusion

We find a conclusion that as increase in the no. of subcarriers using particular pilot space and increase in number of pilots for particular number of subcarrier we got ideal BER at lower SNR. As well as also got nice channel estimation so BER would be low. For transmitting no. of large OFDM symbols then by using large number of subcarrier benefit is number of loop required for simulation is also very much minimized.

V. References

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