Channel Matrix Analysis of Mimo-Ofdm System

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Abstract **- Fourth-generation (4G) wireless communication system is mainly based on MIMO (multiple input and multiple output) and OFDM (orthogonal frequency division multiplexing). The combination of these two techniques leads to a better system, known as OFDM-MIMO system, providing higher capacity and ata rate. This paper demonstrates the BER (bit error rate) performance of OFDM and OFDM-MIMO system using convolution code to encrypt the data stream that can be sent over communication channels. Simulation is made on Matlab using three different channels. The simulation results show that the combined system has better performance compared to OFDM system.**

Keywords- MIMO, OFDM, BER, **Matlab.**

I. INTRODUCTION

In the OFDM system bandwidth is divided into the number of narrowband sub-channels that are orthogonal to each other. In this approach, each carrier is modulated by the low data rate of transmission band-width. This is the best technique for transmission of the high data. This technique can mitigate the effect of inter-symbol interference and inter-carrier interference. Wireless communication MIMO system consists of multiple antennas that are present at the transmitter side and receiver side. MIMO system is used for reliability and to improve the performance of the system.

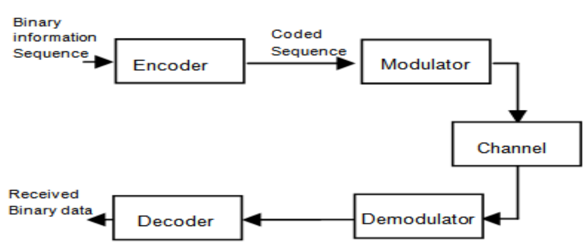

Figure 1: Generic block diagram of digital communication system

Wireless communication for time-variant channels becomes more important by the fast development of intelligent transportation systems which motivates us to propose a reduced rank channel estimator for time-variant frequency-selective high-speed railway (HSR) systems and a reduced rank channel predictor for fast time-variant flat fading channels. Moreover, the potential availability of large bandwidth channels at mm-wave frequencies and the small wavelength of the mm-waves, offer the mm-wave massive multiple-input multiple-output (MIMO) communication as a promising technology for 5G cellular networks.

Challenges in MIMO system

1. Larger MIMO- more than hundred low power antenna (approximately 1mW) places on a Base station to increase the performance of MIMO system.
2. Estimation of practical impairment- in practical communication system major factor like timing offset, phase shift, frequency offset affect the system performance. The estimation of these several factors as well as the compensation of these factors are a major challenge.
3. MIMO relaying network- Combined the cooperative and MIMO technologies to increase the channel capacity, coverage area and channel reliability.
4. Reduce the hardware and software complexity, thermal problem due to increase antenna structure on both side of antenna of the MIMO system.
5. Reduce the Antenna spacing problem which occur difficulty in MIMO communication.
6. Heterogeneous network- combined the macro-cell, Pico-cell and femto-cell together to increase indoor coverage as well as power efficiency
7. Multicell MIMO- equipped multiple base station with multiple antenna is a main challenge in interference mitigation 8. Reduce the problem of power consumption

II. THEORTICAL OVERVIEW AND IMPLEMENTATION DETAILS:

A. *MIMO Systems with Spatial Multiplexing*

Multi-antenna systems have been investigated for several decades, and is one promising technique to significantly improve the spectral efficiency and the reliability. Multiple

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antennas have been adopted by several current wireless communication standards such as WiMAX, LTE and LTE-A [2, 3], and successfully deployed in some countries for broadband wireless access. In this subsection, MIMO with spatial multiplexing configuration has been discussed including several conventional detection algorithms and iterative processing. Spatial multiplexing techniques can substantially maximize the data rate by sending multiple independent data streams simultaneously through multiple transmit antennas. The capacity of MIMO channels may be achieved using spatial multiplexing. The details about the capacity of MIMO channels can be found in [4].

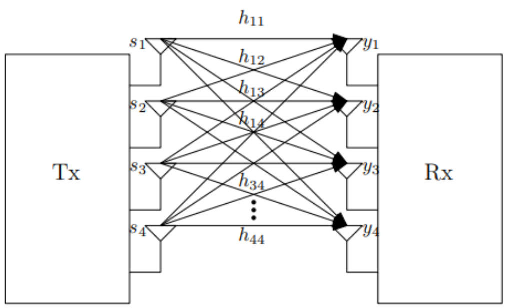

Figure 2: A 4 x 4 MIMO system model

B. Random Integer Generator:

The function of this program is to quickly give output of n random integers in the range from a to b and user specifies whether output is sorted or random order in nature and user can specifies whether to remove duplicate integers or to allow duplicate integers. It generates randomly distributed and uniformly distributed integers.

C. AWGN Channel:

The AWGN channel function is to add white Gaussian noise to the input signals. The term noise is the unwanted electrical signals that are always present in electrical systems and the additive means the noise is super imposed to the signal that tends to mask the signal where it will limit the receiver ability to make correct symbol decisions.

D. OFDM Principle:

It is increasingly believed that OFDM results in an improved downlink multimedia services requires high data rates communications, but this condition is significantly limited by inter-symbol interference (ISI) due to the existence of the multiple paths. Multicarrier modulation techniques, including OFDM modulation are considered as the most promising technique to combat this problem [4] OFDM technique is a multi-carrier transmission technique which is being recognized as an excellent method for high speed bi-directional wireless data communication.

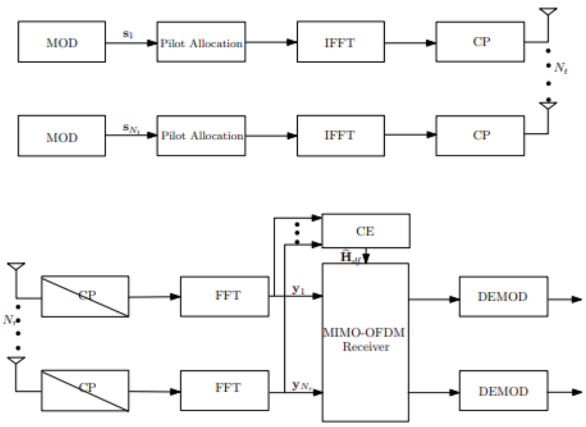

Figure 3: Block diagram of MIMO OFDM model

In wireless, satellite, and space communication systems, reducing error is critical. Wireless medium is quite different from the counterpart using wires and provides several advantages, for example; mobility, better productivity, low cost, easy installation facility and scalability. On the other hand, there are some restrictions and disadvantages of various transmission channels in wireless medium between receiver and transmitter where transmitted signals arrive at receiver with different power and time delay due to the reflection, diffraction and scattering effects. Besides the BER (Bit Error Rate) value of the wireless medium is relatively high. These drawbacks sometimes introduce destructive effects on the wireless data transmission performance.

III. OFDM SYSTEM

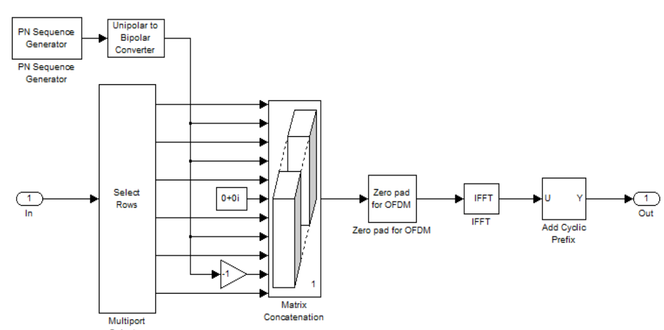

Figure 4: OFDM transmitter

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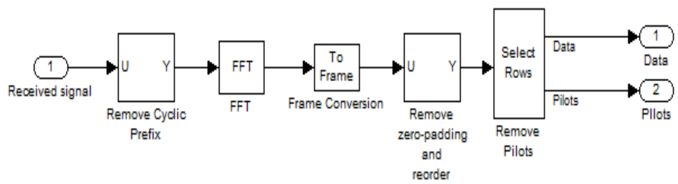

Figure 5: OFDM receiver

A. *QAM Modulator:*

The Rectangular QAM Modulator Baseband block modulates using M-ary quadrature amplitude modulation with a constellation on a rectangular lattice. The output is a baseband representation of the modulated signal. The signal constellation has M points, where M is the **M-ary number** parameter. M must have the form 2^K for some positive integer K. The block scales the signal constellation based on how you set the **Normalization method** parameter.

IV. Results And Discussion

A. *Result Of First Simulation:*

In this simulation the Bernoulli binary generator block generates the random binary numbers using a Bernoulli distribution. This block acts as a information source. Here we are using BPSK, 16-QAM & QPSK modulation scheme. The signal is passed through the AWGN channel. This is acting as a noise source. During the simulation, the performance is evaluated for various Eb/No i.e. 0 to 18dB. The characteristics of the AWGN channel are changed by varying Eb/No from 0to 18 dB to observe the BER performance. The Error rate calculation block compares the input data and the data received after demodulation and calculates the error rate. The display will show the BER at the end of simulation..For convolutional codes we need to set the rate & constraint length parameters for convolutional encoder.

Table 1: Comparison with different modulator in terms of BER

S.NO	E_b /N_o (dB)	BPSK	16-QAM	QPSK
1.	1(dB)	0.475	0.0091	0.5
2.	2(dB)	0.4833	0.00412	0.4958
3.	3(dB)	0.4542	0.000154	0.5083
4.	4(dB)	0.3438	0.0000414	0.5417
5.	5(dB)	0.1771	0.00000216	0.4833
6.	7(dB)	0.0294	0.000000323	0.3775
7.	10(dB)	0.000107	0.000000014	0.1156
8.	12(dB)	0.000023	0.0	0.03612
9.	15(dB)	0.0000045	0.0	0.0004509
10,	18(dB)	0.00000012	0.0	0.0000232

B. *Simulation With Error Correcting Convolutional Codes With OFDM (CC-OFDM) With AWGN Channel:*

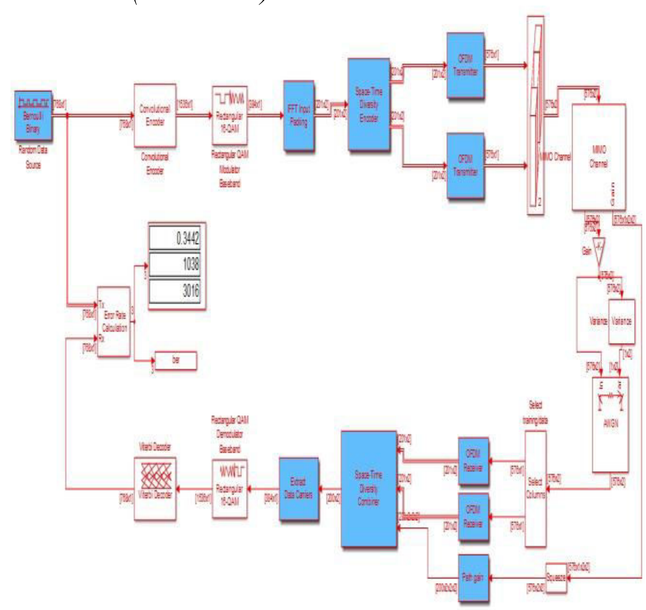

Figure 6: Simulation of MIMO- OFDM system with AWGN channel using 16-QAM modulation

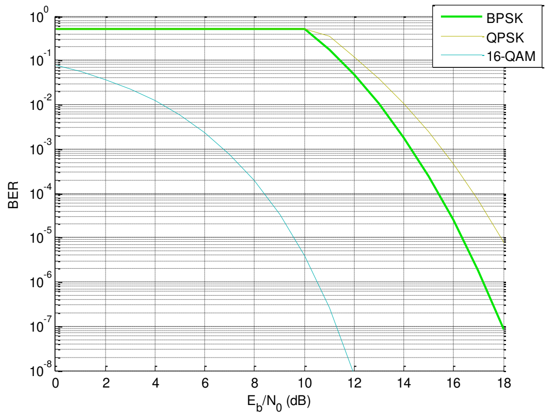

Figure 7:Plot of BER V/S $E_B/N_O$for Convolutional coding with different modulation technique

C. Result Of Second Simulation:

Table 2: Performance evaluation of CC-OFDM with 16-QAM modulator

S.NO	E_b/N_o(dB)	16-QAM
1.	1(dB)	**0.5016**
2.	2(dB)	**0.4982**
3.	3(dB)	**0.4979**
4.	4(dB)	**0.4743**
5.	5(dB)	**0.4678**
6.	7 (dB)	**0.3753**
7.	10(dB)	**0.0571**
8.	12(dB)	**0.0022**
9.	15(dB)	**0.0**
10.	18(dB)	**0.0**

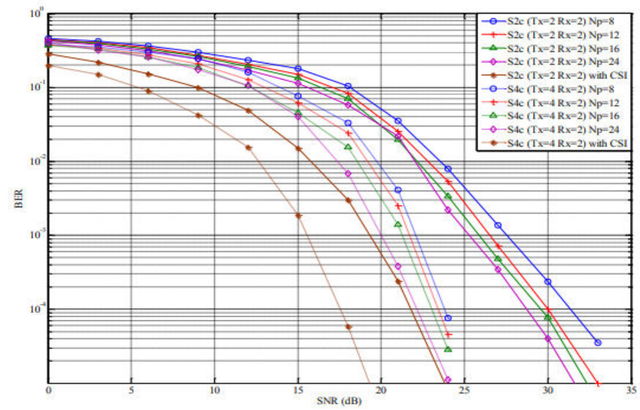

Figure 8: Simulation Results for 2 and 4 transmit Antenna with 2 Receive Antennas with 64 QAM under SUII

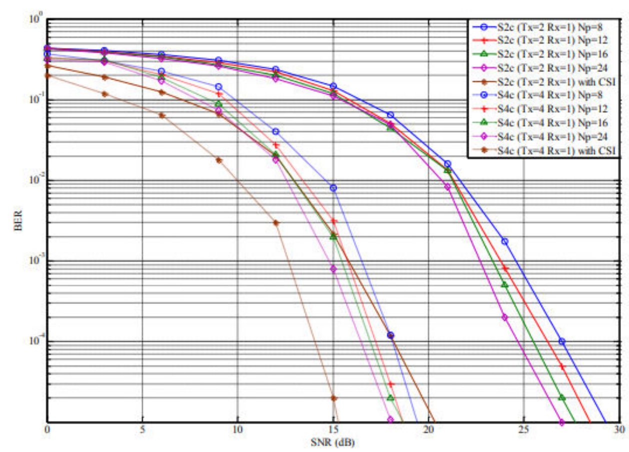

Figure 9: Simulation results for 2 and 4 transit antennas with 1 receive antennas with 16 QAM

V. Conclusion

In this work, we estimate the communication channel matrix in MIMO wireless environment. The basic understanding of MIMO system with its mathematical description is provided here. In this report brief overviews of various estimation techniques are explained. Here we use maximum likelihood as the estimation technique because, it provide consistent approaches to parameter estimation problem. At the end, the simulation results of estimated MIMO channel matrix parameters are provided. The result is compared with 10 transmitter and receiver antenna elements.

VI. Future Work

Evaluate the response of the MIMO system by implementing different modulation schemes. Calculate the accuracy of the estimated channel by evaluating the bit error rate of the MIMO system. Measure the capacity of the MIMO system.

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