OPTIMUM BER SIMULATION OF MIMO 3X3 CHANNEL APPLYING BPSK MODULATION INDEXING AND STANDARD THRESHOLD SCHEME

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ABSTRACT

A specification test of 3x3 MIMO (multi-input multi-output) united with OFDM (orthogonal frequency division multiplexing) transmission system and BPSK (binary phase-shift keying) modulation indexing have been implemented. The BER execution of the system has been resolved for AWGN (additive white Gaussian noise) forwarding flat fading Rayleigh channel. The objective of this paper is to introduce a modulation indexing on the design of MIMO-OFDM system. That provides the aim of achieving the lowest and optimum bit error rate (BER) while increasing the system capacity using multicarrier delay diversity modulation (MDDM), proposed for fifth generation systems. This paper proposed BPSK modulation based threshold scheme. This segmentation method separates high intensity regions from the corresponding modulated frequency outputs. Result shows each modulated frequency intensity value with respect to a standard threshold value and comparison with others modulation scheme in MIMO to implement the bit error rate performance was simulated using Matlab.

KEYWORDS: *MIMO-OFDM, BPSK Modulation index, Standard Threshold Value (STV).*

I. INTRODUCTION

One of the central perceptions of the wireless management objective is communication possible constantly and the user can access in smart fashion. High quality of services (QoS) is provided in 5G (Fifth Generation) wireless communication system [1]. MIMO-OFDM that need to be addressed so that the performance is gained by the wireless technology perfectly. The main hindrance in implementing the 4 × 4 MIMO system was found to be the latency obtained by dealing with the channel matrices for MIMO-OFDM detection [2]. 4G (Fourth Generation) broadband wireless is approved with growing requirement for better achievement by the use of different antennas at both transmitter and receiver station. Different, multiple antenna technologies gain tremendous quantity matched for multimedia benefits and increase range and accuracy [3].

A MIMO system associated not only on the number receiver and transmitter but related with the environment of the antennas. That analyzed the view of the mutual coupling is more robust, and results showed overview of mutual coupling with wavelength at different antenna [4]. In [5], provides an application of unified expression including joint probability density function, central Wishart, Gaussian quadratic forms, covariance matrix and good performance analysis, whereas MIMO Rayleigh fading channels and multiple MIMO interferers are existence. To define best communication performance MIMO-OFDM with BPSK modulation, carrier frequency with low data rate stream are modulated at transmitter and receiver ends to recover capacity of over single antenna topologies. OFDM can be handled in combination with MIMO transceiver to improve the diversity gain and the system better ability by applying spatial domain. Since OFDM-MIMO system provides various parallel narrowband channels, high-data rate systems [6].

Another proposed an MMSE equalizer for TxAA based MIMO transmission design that is ready to remove the intra-cell intrusion. Fading simulations resulted the new equalizer has outer performed for the single user MMSE equalizer. OFDM signal is transmitted through a different number of antennas in order to achieve diversity gain or to gain higher data rate that is defined as MIMO-OFDM [7, 9]. In [10], MIMO systems provide a powerful data throughput comparison with SIMO systems. Incrementing the number of receivers - transmitters will upgrade the level of intrusion cancellation and will promote the throughput of MIMO systems.

Paper on [11] referred an innovative threshold receiver for MIMO-OFDM system. Proposed scheme calculates the channel condition number and then selects either combined V algorithm and CLLL or combined QRD-M and DFE detection scheme according to channel information. The complexity of the proposed scheme is implemented for 4×4 MIMO-OFDM system. Paper presented a result analysis of BPSK modulation in MIMO-OFDM combination of ASTC encoding; it sent data using compatible structure with outage capacity [12].

The objective of this proposed paper is to expand a MIMO-OFDM system with BPSK modulation indexing comparing with STV (Standard Threshold Value) which has near optimal BER with much reduced computational complexity and the best channel performance.

II. SYSTEM MODEL AND TRANSMISSION SCHEMES

MIMO system is sending and receiving multiple signals simultaneously. So it is better support to diversity. The paper is restricted to the frequency flat fading channel, and therefore the corresponding input-output [13]-[14] relationship simplifies to:

$$\boldsymbol{y} = \boldsymbol{Hs} + \boldsymbol{n} \quad (1)$$

Here applied the MDDM Transmitter & Receiver [13], the simulation was implemented without added guard interval,equal power was transmitted from each antennas. It is supposed that the frequencies are matched for analysis and simulation function and diversity obtains are also proportioned. MDDM experimented on AWGN and fading was unrecognized.

The Assume that bandwidth of OFDM system is divided in K subcarriers. The symbol duration of the input serial data is'T_S'' with serial data rate of $f_S' = \frac{1}{T_S'}$ .Therefore, if the number of parallel data streams is equal to the number of OFDM subcarriers, the symbol duration for OFDM will be T_S=KT_S' for OFDM signal that denotes that the symbol period is K times greater than that of individual sequential stream symbol period. The OFDM transmitted signal $S(t)$was denoted as:

$$S(t) = \sum_{m=0}^{K-1} A\{d_{I_m}\cos(2\pi f_m t) - d_{Q_m}\sin(2\pi f_m t)\} \quad (2)$$

$$= \sum_{m=0}^{K-1} a_m \left\{ \frac{1}{\sqrt{{d_{I_m}}^2 + {d_{Q_m}}^2}} \cos(2\pi f_m t) - \frac{1}{\sqrt{{d_{I_m}}^2 + {d_{Q_m}}^2}} \sin(2\pi f_m t) \right\} \quad (3)$$

$$= \sum_{m=0}^{K-1} a_m \{\cos(2\pi f_m t) + \cos(\theta_m) - \sin(2\pi f_m t) + \sin(\theta_m)\} \quad (4)$$

Where$\theta_m = \tan^{-1}\left({d_{Q_m}}/{d_{I_m}} \right)$The correlation between any two symbols transmitted on separate subcarriers, represented as r_{ij}must be equal to zero to maintain the orthogonality of subcarriers

$$R_{ij} = \int_{-\infty}^{+\infty} s_i(t) s_j(t) dt \quad (5)$$

$$= \int_0^{T_s} a_i \cos(2\pi f_i t) + \theta_i t) a_j \cos(2\pi f_i t) + \theta_i t) dt \quad (6)$$

Using the trigonometric identity

$$\cos(\alpha)\cos(\beta) = \frac{1}{2}\cos(\alpha+\beta) + \frac{1}{2}\cos(\alpha-\beta)$$

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$$R_{ij} = \frac{a_i a_j}{2}\int_0^{T_s}\left(\cos(2\pi(f_i+f_j)t + (\theta_i+\theta_j)t + \cos(2\pi(f_i-f_j)t(\theta_i)t)\right)dt \quad (7)$$

Where a_i , a_j are constant for the symbol duration. For $2\pi(f_i+f_j) \gg \frac{1}{T_s}$ than

$$R_{ij} = \frac{a_i a_j}{2}\int_0^{T_s}\left(\cos(2\pi(f_i-f_j)t(\theta_i-\theta_j)t)\right)dt$$

R_{ij} **= 0** if $(f_i+f_j)T_s$ **= M** where **M** $\in$set of positive integers

$$\Rightarrow (f_i - f_j) = \frac{M}{T_s} \quad (8)$$

Therefore, minimum frequency separation between two consecutive subcarriers to maintain orthogonality must be :

$$\Delta f = \frac{1}{T_s} = f_s \quad (9)$$

where f_s is the rate of OFDM symbol. In order to eliminate the ISI completely due to the time delay spread of the multipath channel, a guard interval is added before each OFDM symbol.

2.1. Simulation of Standard Threshold Value

The value of the modulation index indicates by how much the modulated variable varies around its un-modulated level. It relates to variations in the carrier frequency, is assigned as:

$$\text{Modulation index} = \frac{\Delta f}{f_m} \quad (10)$$

Where, Δf is frequency deviation and f_m is OFDM modulating signal frequency. It stored every BPSK modulating results like 0.5, 0.1 and 1.0 (fig. 2), which can easily make a group of higher modulated frequency signal. Than variance based selection is applied to pick the less noise, attenuation modulating signal. Experiment chooses BPSK modulation because its bit error rate is less than other modulation scheme shown in fig. 1.

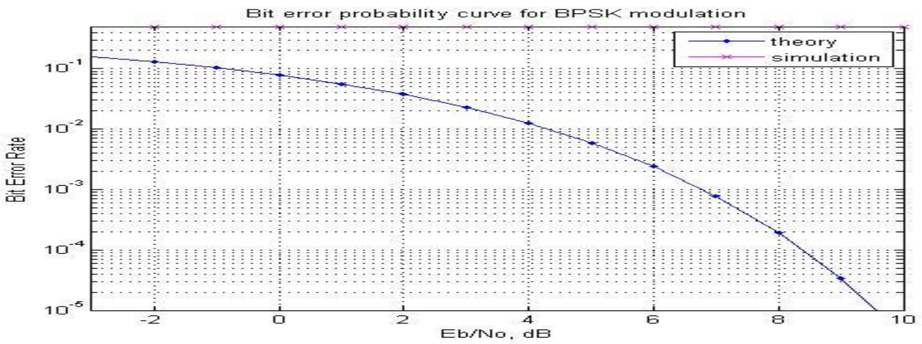

Figure 1: Probability of BER using BPSK modulation scheme

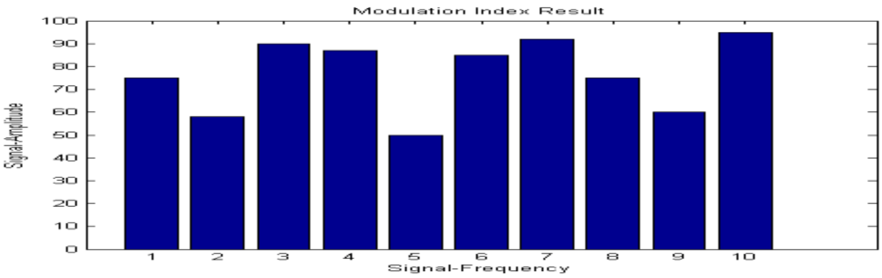

Figure 2: Modulation indexing

Finding modulated frequency a STV formula is applied, this threshold operation can be expressed as:

$$tsv(x,y)=\begin{cases} maxFrequency & if\ src(x,y) > thres \\ 0 & otherwise \end{cases} \quad (11)$$

So, if the intensity of modulated frequency $src(x,y)$ is higher than **thres** value, then the new value intensity is set to a **MaxFrequency**. Otherwise, the signal frequency is set to 0. Charting a group of threshold value, easily it separated the higher modulated frequency signal from the lower frequency signal. The rest modulated signals are discarded. Finally it forwarded the separated signal through MIMO (3, 3) channel.

2.2 Simulation and Environment setup for performance

In this paper, the number of subcarriers is 256 for OFDM simulation. Data symbol in the OFDM is 192.All pilot symbols for channel matrix set to ones. The guard ratio is chosen to be 1/32.Therefore, the guard length is to be 8.The cyclic prefix constitutes the last eight samples of the IFFT output and it is concatenated to the beginning of the OFDM symbol sequence. For each case of BPSK the result part is compared with a threshold level to decide each received modulated signal. The number transmit antennas is three and the transmit antennas transmit equal power. For analysis and simulation purpose it is assumed that the transmitter and receiver frequencies are synchronized and MIMO (3x3) system, all the diversity receptions are also synchronized.

III. Performance Analysis Of MIMO System With Three Transmitting And Three Receiving Antennas

The achievement test of MIMO system with three transmit and three receive antennas is analysed in equation term and performance of output is shown fig. 3. As 3*3 MIMO simulated, SISO, MISO, and SIMO are also simulated and illustrated in figure 4, so that it can be easily compared and analyzed the result as well as realized the performance of the system. It is also assumed that the signal receptions at all antennas are uncorrelated and signals are received at the same time without any relative delay. The received signals at the three receive antennas are given by:

$$r_m^1 = x_m^1 + x_m^2 + x_m^3 + n_m^1$$

$$r_m^2 = x_m^1 + x_m^2 + x_m^3 + n_m^2$$

$$r_m^3 = x_m^1 + x_m^2 + x_m^3 + n_m^3 \quad (12)$$

After the FFT operation the signal are represented as:

$$R_k^1 = X_k^1 + X_k^2 + X_k^3 + N_k^1$$

$$R_k^2 = X_k^1 + X_k^2 + X_k^3 + N_k^2$$

$$R_k^3 = X_k^1 + X_k^2 + X_k^3 + N_k^3 \quad (13)$$

Noise factors at both receive antennas are IID Gaussian random variables. Therefore the signal whole deviation of noise factor is the addition of their separated deviation. The total variance is given as:

$$\sigma_{\tau_k}^2 = \sigma_{\tau_k^1}^2 + \sigma_{\tau_k^2}^2 + \sigma_{\tau_k^3}^2 \quad (14)$$

$$\sigma_{\tau_k}^2 = \frac{a[1+cos(\emptyset_k)]N_o}{2T_b} \quad (15)$$

$$\sigma_{\tau_k} = \sqrt{\frac{a[1+\cos(\emptyset_k)]}{2T_b}} \cdot \sqrt{N_o} \quad (16)$$

$$P_b^r = \left(\frac{3\sqrt{2[1+cos(\emptyset_k)]A}}{\sqrt{2[1+cos(\emptyset_k)]N_o/2T_b}}\right) = Q\left(\sqrt{\frac{12[1+cos(\emptyset_k)]A^2T_b}{N_o}}\right)$$

$$= Q\left(\sqrt{\frac{12[1+cos(\emptyset_k)]E_b}{N_o}}\right) \quad (17)$$

$$P_b = \frac{1}{192}\left(\sum_{k=9}^{100} Q\left(\sqrt{\frac{12[1+cos(\emptyset_k)]E_b}{N_o}}\right) + \sum_{k=156}^{255} Q\left(\sqrt{\frac{12[1+cos(\emptyset_k)]E_b}{N_o}}\right)\right) \quad (18)$$

IV. RESULT ANALYSIS

The simulation result was conducted for the same number of OFDM frames or data symbols. The simulated bit error rate (BER) for the MIMO system is plotted in figure 3,4,5,6 with compared to SISO, MISO and SIMO. Modulating index applied to 3*3 and compared to 1*2, 2*2 system also.

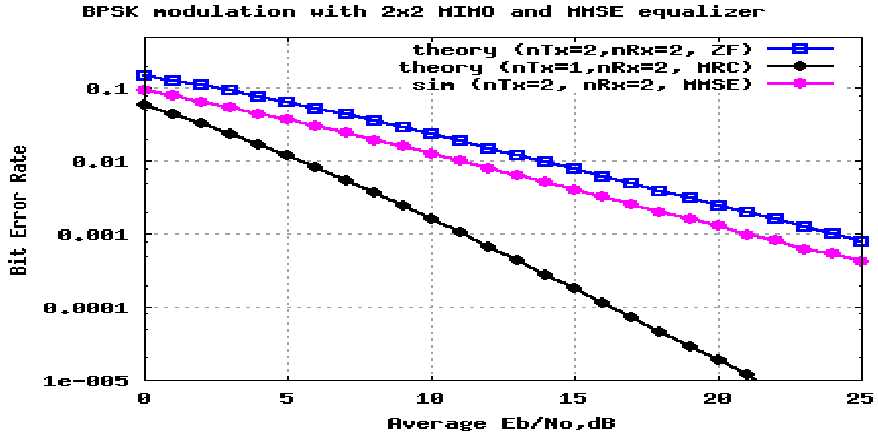

Figure 3: Result MIMO performance with MMSE equalizer

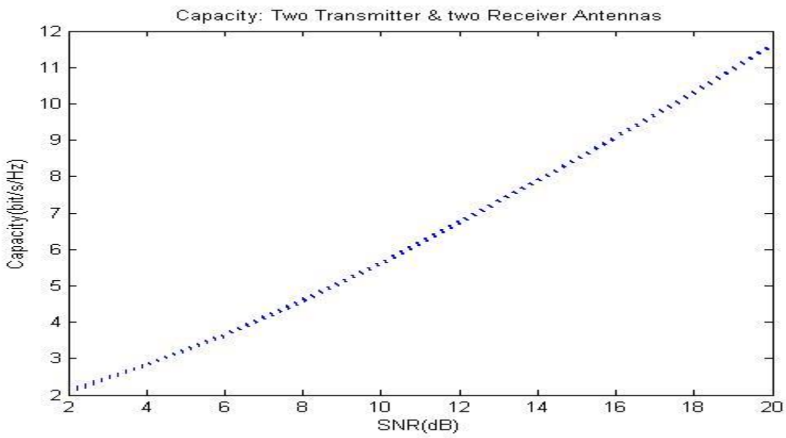

Figure 4: Simulation result of 2*2-MIMO system in AWGN

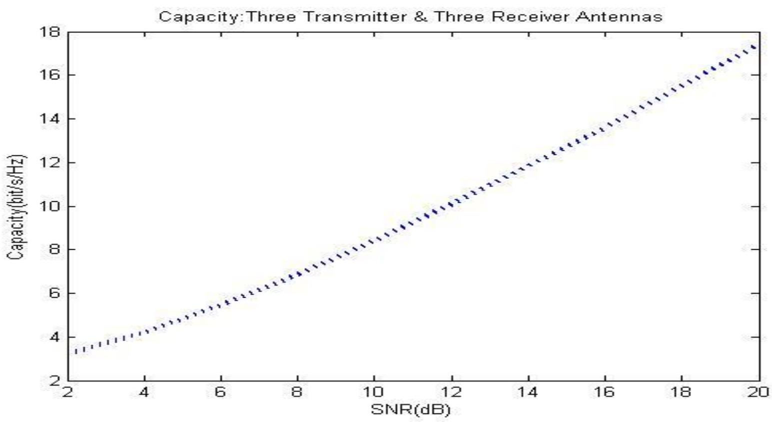

Figure 5: Simulation result of 3*3 MIMO system in AWGN using modulation indexing

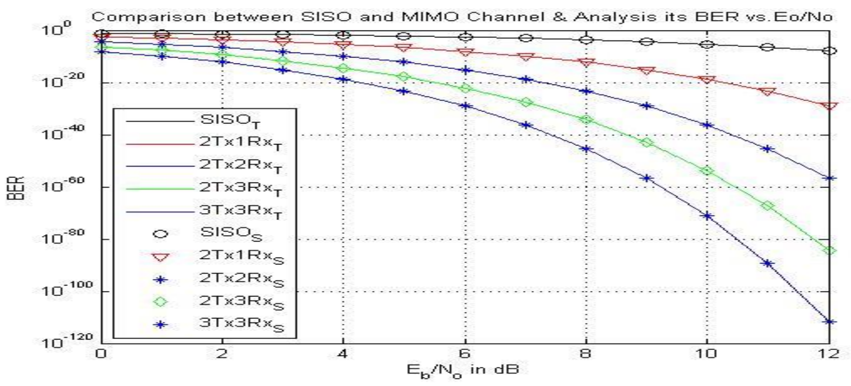

Figure 6: Comparison between SISO and MIMO Channel & Analysis its BER vs. Eo/No with several variance

V. CONCLUSIONS

The performance of MIMO 3x3 analyzed 5dB difference in the required SNR for a specific target BER while different MIMO system are considered. The data rate and transmitted capacity for SISO and MIMO systems are alike for reasonable differentiation. The performance in AWGN shown that MIMO (3x3) system executed superior than SISO for low bit error and results shows three receive antennas and three receive antennas gain 3.3 dB performances. So, here is diversity gain higher than others technology. For 3x3 MIMO systems with OFDM multiplexing techniques and threshold coding for BPSK modulation, the MDDM shows better BER performances for digital transmission. The BPSK modulation indexing and threshold coding system shows ~4dB improvement in the SNR compared to the MMSE, ZF receiver system for achieving same BER values. This model also showed remarkable deficiencies when compared to the measurements with large scale.This model would be expanded to present the best performance whatever the received powers on different antennas for high spectral efficiencies.

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