International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Performance of MIMO Systems Over Weibull Fading Channel using Maximal Ratio Combining

Smt. D.Lalitha Kumari, M.N.Giri Prasad

Abstract—Multiple Input Multiple Output (MIMO) wireless systems are perceived a significant reorganization for upcoming wireless systems. The performance of communication systems in regards to their spectral efficiency and ability is enhanced as a result of MIMO systems. The required transmit power as for desired Bit Error Rate (BER) has been outfitted in combination with appropriate receiver diversity. The study exposed that MIMO is a further efficient energy system since accomplished a decent BER performance at low SNR, when compared with SISO, SIMO and MISO which needs high SNR to accomplish at appropriate BER performances. The multiplexing gain experienced in the multiple antenna strategies utilizing the Space Time Block Code (STBC) and Maximal Ratio Combining (MRC). The impacts of number of transmitter and receiver antennas on the MIMO system's BER performance over Rayleigh, Rician and Weibull channels with STBC transmitter and MRC receiver is analyzed. The BER performance characteristics of MRC receiver is explored for Quadrature Phase Shift Keying (QPSK) modulation.

Keywords—MIMO, BER, STBC, MRC, QPSK, Rayleigh, Rician, Weibull.

I. INTRODUCTION

The appeal for bandwidth puts an incredible responsibility on the hands of Communication Engineers to outline antennas with high bandwidth. High rates of data can be accomplished by utilizing the multiple numbers of antennas at both receiver and transmitter through multiplexing and performance can be enhanced through diversity contrasted with systems which have single antenna in wireless communication technology. The system that makes utilization of a different number of antennas at the receiver and transmitter is introduced as MIMO systems. It is a technology of smart antenna which enhances the performance of a wireless communication technology, with no additional cost on communication assets. With MIMO, the capacity of communication system increments directly with the quantity of antennas, in this manner accomplishing a spectral efficiency expansion, without demanding more parameters as far as power and bandwidth. There are various distinctive MIMO configurations or designs that can be utilized in antenna technology. These are named as SISO, MISO, SIMO and MIMO. These particular MIMO formats offer distinctive preferences and hindrances; these can be changed to give the optimum solution for any given application.

Revised Manuscript Received on December 30, 2019.
***** Correspondence Author
Smt. D.Lalitha Kumari*, Research Scholar, Dept. of ECE JNTUA College of Engineering, Ananthapuramu, India. lalithad29@gmail.com
Dr. M.N.Giri Prasad, Professor, Dept. of ECE JNTUA College of Engineering, Ananthapuramu, India. griprasadmn.ece@jntua.ac.in

In this project, we look at the effects of channels with fading like Rayleigh, Rician and Weibull channels on the MIMO systems performance utilizing MRC receivers.

The AWGN channel model is an ultimate channel scheme for many modulations. Rayleigh distribution approximated by destructive and constructive behavior of multipath parts in faded channels. There are no line of sight ways which infers when immediate path between receiver and transmitter is not present. Moreover, multi-path segments in flat-fading channels can likewise be imprecise by distribution of Rician when there is direct way between transmitter link and receiver link. The Weibull distribution is versatile model for depicting multi-path channels for indoor as well as outdoor propagation conditions. The utilization of a Weibull model examination to present changes in the base of model distribution, to minimize some inadequacies of distribution of Rayleigh.

II. SYSTEM MODEL

The MIMO's system simulation model made as in Figure1. It comprises of a Transmitter block, the multipath channel and the receiver block. The quantity of transmitting and receiving antennas is the size of MxN, where M speaks to the quantity of antennas at the transmitter side and N speaks to the quantity of antennas at the receiver side. As such, 1x2, 1x3, 1x4, 2x2, 2x3, 2x4 antenna configurations are considered. A certain number of bits transmitted to the QPSK modulation and MIMO encoder at the transmitter. The encoded information correlated with channel coefficients, when they went through the multipath fading channel. The corresponding data send to the MIMO decoder and QPSK demodulator. The data, which utilized at BPSK modulation and the data, which extricate from demodulation of BPSK are looked at for BER.

A. MIMO Encoding

Consider A 2x2 MIMO system, which consists of two transmitter antennas and two receiver antennas. The STBC scheme is used as transmit diversity at transmitter part. Transmission encoding sequence for the STBC two transmitter antennas as shown in the table.

Time /Space	Antenna1	Antenna2
Time (t)	c_1	c_2
Time (t+T)	$-c_2^*$	c_1^*

At time slot (t) the data c_1 and c_2 are transmitted and at time slot (t+T) the data $-c_2^*$ and c_1^* are transmitted. Similarly the generalized data sequence through two transmitter antennas is

$$C = \begin{bmatrix} c_1 & -c_2^* & c_3 - c_4^* & - & -- & c_{L-1} & -c_L^* \\ c_2 & c_1^* & c_4 \; c_3^* & - & -- & c_L & c_{L-1}^* \end{bmatrix}$$

B. *MIMO Channel*

Consider a wireless multipath channel with fading as

$$h(t,\tau) = \sum_{k} \gamma_k(t)c(\tau - \tau_k)$$

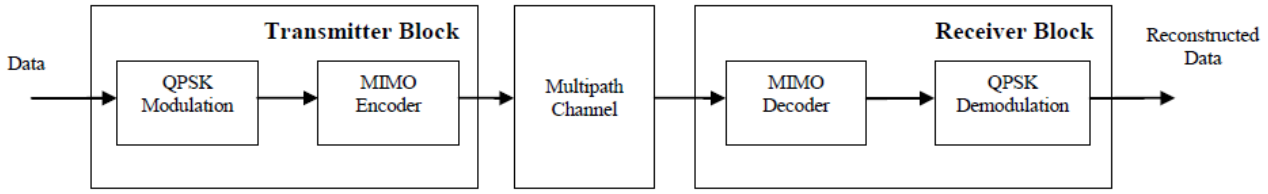

Figure 1, Block diagram of MIMO transceiver

where $h(t,\tau)$ is an impulse response of the baseband channel, τ_k indicates different delay paths, c(t) is shaping pulse, $\gamma_k(t)$ is the complex independent magnitude of the k^{th} path. Various statistical distributions, depending on the characteristics of channel can be characterized $\gamma_k(t)$. Transmission channel of the MIMO can be modeled as an MxN matrix as represented in below given equation,

$$h(t,\tau) = \begin{bmatrix} h_{11}(t,\tau) & h_{12}(t,\tau) & . & . & . & h_{1N}(t,\tau) \\ h_{21}(t,\tau) & h_{22}(t,\tau) & . & . & . & h_{2N}(t,\tau) \\ h_{31}(t,\tau) & h_{32}(t,\tau) & . & . & . & h_{3N}(t,\tau) \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ h_{M1}(t,\tau) & h_{M2}(t,\tau) & . & . & . & h_{MN}(t,\tau) \end{bmatrix}$$

Where $h_{MN}(t,\tau)$ is an impulse response between the M^{th} transmitter and N^{th} receiver. A MIMO (2x2) system with channel paths is represented in figure2,

1) *Multipath Fading:*

Multipath fading is generated by atmospheric ducting, refraction and reflections of ionosphere from different objects, so arbitrarily deferred, scattered, diffracted and reflected components of signal consolidate in a constructive and destructive manner. Short term signal variations caused by multipath channel fading, and its effect on the envelope of signal has been measurably demonstrated by different models up until now. Consider three types of channel models, such as Rayleigh, Rician and Weibull channels.

2) *Rayleigh Fading Channel*

The most normally utilized distribution for fading is the distribution of Rayleigh with probability density function (PDF) is given as

$$f(m) = \frac{m}{\sigma^2} exp\left(\frac{-m^2}{2\sigma^2}\right), m \geq 0$$

Here, it is expected that all signals endure almost the similar attenuation, however arrive with various phases. The random variable according to the magnitude of signal is m. Here σ^2 is represented as variance of the elements of In-phase and Quadrature-phase.Theoretical examinations show that the whole of these signals will bring about the magnitude having the distribution of Rayleigh of above condition. This is likewise supported by various frequency measurements. The phase of the complex envelope of the received signal is typically thought to be distributed uniformly in [0,2π].
Let consider two statistically Gaussian distributed independent random variables with mean as zero and variance as σ^2, then the envelope given as

$$m = \sqrt{{X_1}^2 + {X_2}^2}$$

would represent a Rayleigh distributed random variable. For extensive estimations of the envelope of received signal in suburban and urban areas, where LOS component is frequently blocked by different obstacles, the model of Rayleigh distribution was recommended as a satisfactory process of envelope model. Rayleigh channel fading distribution is also called as the scatter distribution.

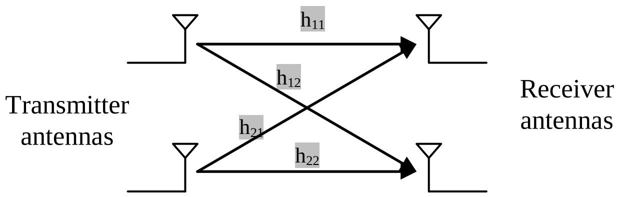

Figure 2, 2x2 MIMO Channel paths

3) *Rician fading channel*

At the point when dominant LOS signal components additionally exist, the distribution is observed to be Rician, the probability density function is given by,

$$f(m) = \frac{m}{\sigma^2} exp\left(\frac{-(m^2 + A^2)}{2\sigma^2}\right) I_0\left(\frac{Am}{\sigma^2}\right)$$

Where σ^2 is the variance of the elements of In-phase and Quadrature-phase. A is the magnitude of the dominant path signal and I_0 is the modified Bessel function with zero-order. Typically the path which is dominant significantly lessens the severity of fading, and as far as BER of Rician channel fading provides better performance to Rayleigh channel fading. The Rician distributionmodified to the Rayleigh distribution in the absence of a dominant path. When A is enormous compared with σ, the distribution here is nearly Gaussian. In this manner, since distribution of Rician includes additionally Gaussian and Rayleigh distribution, scientifically the fading channel of Rician can be thought to be general case.Give us a chance to begin from two statistically independent Gaussian distributed random variables X1 and X2, each with zero mean and variances σ^2, then

$$m = \sqrt{(X_1 + A)^2 + {X_2}^2}$$

Would indicate Rician distributed random variable. Distribution of Rician is regularly described as far as a fading parameter of k, which characterizes the proportion of signal power in the dominant element of the required signal and the scattered power.

The fading parameter k characterized as

$$k = \frac{A^2}{2\sigma^2}$$

To reproduce Rician fading channel, mean and sigma have been figured with the given Rician k factor. Let's define mean and sigma as given below

$$A = \sqrt{\frac{k}{k+1}} \quad \text{and} \quad \sigma = \sqrt{\frac{1}{2(k+1)}}$$

as discussed above, in Rician fading, the dominant predominant X_1has to be a random variable of gaussian with mean and sigma, however scatter component X_2 has to be created with mean = 0 and sigma = σ.

4) Weibull Fading Channel

The PDF in the distribution of Weibull is given as,

$$f(m) = \frac{\alpha m^{\alpha-1}}{2\sigma^2} exp\left(\frac{-m^{\alpha}}{2\sigma^2}\right)$$

where α Non-linearity parameter and $2\sigma^2$ is average power. Nonlinearity is acquainted to model some propagation phenomenon. The Non-linearity parameter α is likewise a measure of fading extremity ($\alpha \geq 0$), because when α increases, the extremity at fading decreases. For extraordinary instance$\alpha = 2$ represents Rayleigh distribution and $\alpha = 1$ represents Exponential distribution. Let us consider Gaussian distributed random In-phase and Quadrature variables X1 and X2 each with equal variances and zero means. The subsequent envelope, acquired as a Non-linear function of above variables sum is

$$m = \sqrt[\alpha]{{X_1}^2 + {X_2}^2}$$

Consider here Clarke's reference model as a multipath fading channel model. This framework is otherwise called mathematical reference model. The flat fading random process with K multiple ways can be simulated with the sum of sinusoid methods described here as

$$h_I(iT_s) = \frac{1}{\sqrt{K}} \sum_{m=1}^{K} cos\left\{2\pi f_D cos\left[\frac{(2m-1)\pi + \theta}{4K}\right] . iT_s + \alpha_m\right\}$$

$$h_Q(iT_s) = \frac{1}{\sqrt{K}} \sum_{m=1}^{K} sin\left\{2\pi f_D cos\left[\frac{(2m-1)\pi + \theta}{4K}\right] . iT_s + \beta_m\right\}$$

$$h(iT_s) = h_I(iT_s) + jh_Q(iT_s)$$

Where θ, α_m and $\beta_m$have uniform distribution over an interval [0, 2π) for all i and are mutually distributed, $f_D$is maximum Doppler frequency, T_s is sampling period, i is sample index. The Rayleigh multipath fading channel envelope utilizing Clarke's model is

$$|h(iT_s)| = \sqrt{|h_I(iT_s)|^2 + |h_Q(iT_s)|^2}$$

Similarly Clarke's reference model used for Rician and Weibull multipath channels. Rician and Weibull multipath fading channel envelopes respectively using Clarke's model is

$$|h(iT_s)| = \sqrt{|h_I(iT_s) + A|^2 + |h_Q(iT_s)|^2}$$

$$|h(iT_s)| = \sqrt[\alpha]{|h_I(iT_s)|^2 + |h_Q(iT_s)|^2}$$

Parameters considered for multipath channel is,

Parameter	Specification
Number of Paths	10
Speed of Vehicle	60 km/h
Doppler spread	100 Hz
Sampling time	0.0001sec

C. MIMO Decoder

The receiver block incorporates MIMO Decoder and QPSK demodulation. This MIMO Decoder comprises of Maximal Ratio Combiner and STBC Decoder. MRC method is utilized to consolidate signals constructively from different diversity branches. The symbol of data to be transmitted is weighted with a weight vector to shape the transmitted vector and branches with a robust signal are additionally intensified, while delicate signals are unamplified. The received signal vector at the receiver side is the outcome of signal vector of transmitter and a channel with Additive Gaussian noise. The resultant data fetched to an STBC decoder.

The received signal at the 1st time moment is,

$$\begin{bmatrix} d^1 \\ {d_2}^1 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \end{bmatrix}$$

Expecting that the channel stays unchangeable for the 2nd time moment, the signal is at the 2nd timemoment is,

$$\begin{bmatrix} {d_1}^2 \\ d^2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} -c_2 * \\ c_1 * \end{bmatrix} + \begin{bmatrix} n_3 \\ n_4 \end{bmatrix}$$

where $[{d_1}^1 {d_2}^1]^T$ and $[{d_1}^2 {d_2}^2]^T$ indicates the received information at time moment 1 with respect to receive antenna 1,2 and the received data at time moment 2 with respect to receive antenna 1,2 respectively, h_{ij} related to coefficient of fading channel from i^{th} transmitter antenna to j^{th} receiver antenna, p_1, p_2 are transmitted symbols, $[n_1\ n_2]^T$ and $[n_3\ n_4]^T$ represents the noise terms at time instant 1 with respect to receive antenna 1,2; combining the given equations at time moments 1 and 2 are, the receiver development at the first time minute is, Enduring that the channel stays unchangeable for the second time moment, the got hail is at the second time minute is,

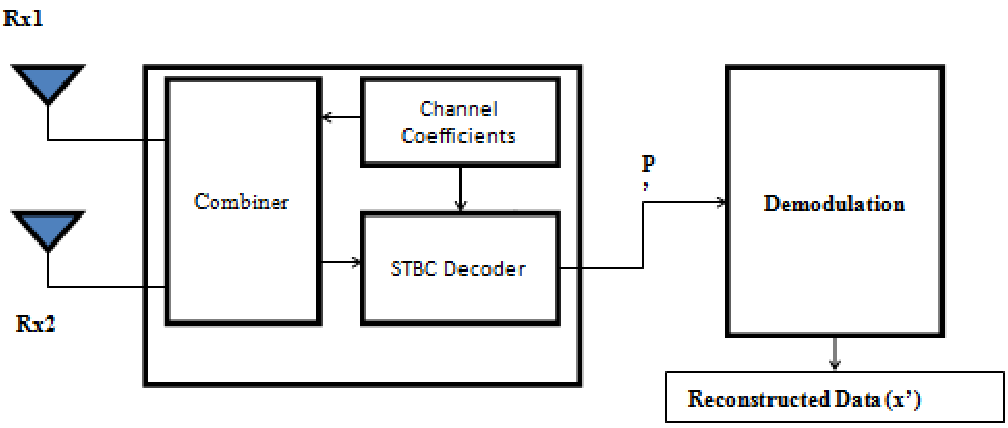

Figure 3, 2x2 MIMO Decoder Block Diagram

$$\begin{bmatrix} {d_1}^1 \\ {d_2}^1 \\ {d_1}^{2*} \\ {d_2}^{2*} \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}* & -h_{11*} \\ h_{22}* & -h_{21}* \end{bmatrix} \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ n_3* \\ n_4* \end{bmatrix}$$

Let the notation of H as,

$$\boldsymbol{H} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}* & -h_{11*} \\ h_{22}* & -h_{21}* \end{bmatrix}$$

To illuminate for $[c_1\ c_2]^T$, require to calculate the inverse of H.

For a general case MxN matrix, the pseudo inverse is composed as,

$$H^+ = (H^H H)^{-1} H^H$$

The term,

$$(H^H H) = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}* & -h_{11*} \\ h_{22}* & -h_{21}* \end{bmatrix}^H \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{12}* & -h_{11*} \\ h_{22}* & -h_{21}* \end{bmatrix}$$

$$(H^H H) = \begin{bmatrix} |h_{11}|^2 + |h_{21}|^2 + |h_{12}|^2 + |h_{22}|^2 & 0 \\ 0 & |h_{11}|^2 + |h_{21}|^2 + |h_{12}|^2 + |h_{22}|^2 \end{bmatrix}$$

The inverse is essentially the backwards of the diagonal components since this matrix is in type of diagonal matrix, i.e,

$$(H^H H)^{-1} = \begin{bmatrix} \frac{1}{|h_{11}|^2 + |h_{21}|^2 + |h_{12}|^2 + |h_{22}|^2} & 0 \\ 0 & \frac{1}{|h_{11}|^2 + |h_{21}|^2 + |h_{12}|^2 + |h_{22}|^2} \end{bmatrix}$$

The estimated kind of signal which transmitted is,

$$\begin{bmatrix} \widehat{c_1} \\ {c_2}^* \end{bmatrix} = (H^H H)^{-1} H^H \begin{bmatrix} {d_1}^1 \\ {d_2}^1 \\ {d_1}^{2*} \\ {d_2}^{2*} \end{bmatrix}$$

Similar procedure for 2x3 and 2x4 antenna configurations to reconstruction of the transmitted signal.

III. BIT ERROR RATE

BER is characterized as the rate at which errors happen in transmission systems during an examined time interval or it can be communicated as the number of receiving data bits over a channel that adjusted because of noise distortion, interference or bit synchronization repetition. BER is a unit less quantity, regularly expressed as a percentage or 10 to the negative power. The meaning of BER can be converted into a simple,

$$BER = \frac{Count\ of\ Error\ Bits}{Count\ of\ Total\ transmitted\ bits}$$

The bit error rate is the count of error bits per unit time. The bit error ratio is the proportion of the count of bit errors to the aggregate number of exchanged bits during a considered time interval. SNR after Maximal Ratio Combining is,

$$SNR_m = \frac{C}{\sigma^2}\left\{\left\|\tilde{h}\right\|^2\right\}$$

where P is average signal power, σ^2 is Noise power, $x = |h|^2$ Incorporates h_{11}, h_{12}, h_{21}, h_{22}, h_{31}---, h_{MN}iid fading channel coefficient vectors with unity average power. x is chi-square random variable and probability distribution function is,

$$F_X(x) = \frac{1}{(L-1)!} x^{L-1} e^{-x}$$

BER examination for a multiple number of antenna systems utilizing MRC technique is

$$BER = Q(\sqrt{SNR_m})$$

$$BER = Q(\sqrt{x\ SNR})$$

Ascertain the average over above expression regarding to determine the average BER of a multi-antenna system. The average BER is

$$Avg\ BER = \int_0^\infty Q\left(\sqrt{x\ SNR}\right) F_X(x)\,dx$$

$$Avg\ BER = \int_0^\infty Q\left(\sqrt{x\ SNR}\right) \frac{1}{(L-1)!} x^{L-1} e^{-x} dx$$

By simplifying the above equations average BER is,

$$Avg\ BER = (z)^L \sum_{k=0}^{L-1} L + k - 1_{C_k} (1-z)^k$$

here L is the diversity order of the MIMO system.

Retrieval Number: B7088129219/2019©BEIESP
DOI: 10.35940/ijitee.B7088.129219
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

BER for 1x2 MIMO systems utilizing the MRC scheme in nearness of the multipath fading channel is,

$$Avg\ BER = z^2(1 + 2(1 - z))$$

BER for 1x3 MIMO systems utilizing the MRC scheme in a nearness of the multipath fading channel is,

$$Avg\ BER = z^3(1 + 3(1 - z) + 6(1 - z)^2)$$

BER for 1x4 and 2x2 MIMO systems utilizing the MRC scheme in a nearness of the multipath fading channel is,

$$Avg\ BER = p^4(1 + 4(1 - z) + 10(1 - z)^2 + 20(1 - z)^3)$$

BER for 2x3 MIMO systems utilizing the MRC scheme in a nearness of the multipath channel is,

$$Avg\ BER = z^6(1 + 6(1 - z) + 21(1 - z)^2 + 56(1 - z)^3 + 126(1 - z)^4 + 252(1 - z)^5)$$

BER for 2x4 MIMO systems utilizing the MRC scheme in nearness of multipath channel is,

$$Avg\ BER = z^8(1 + 8(1 - z) + 36(1 - z)^2 + 120(1 - z)^3 + 330(1 - z)^4 + 792(1 - z)^5) + 1716(1 - z)^6 + 3432(1 - z)^7)$$

Where zis BER for QPSK in a Rayleigh or Rician Channel by utilizing 2 transmit antenna STBC scheme.

IV. SIMULATION RESULTS

In this segment, the analysis of BER of MIMO system performance of QPSK for transmit diversity STBC and receive diversity MRC is show in Rayleigh, Rician and Weibull fading channels.

Fig.4 shows that BER reduces monotonically with an increase in E_b/N_0. Here 1x2, 1x3 and 1x4 systems are compared with MRC receiver diversity in the presence of the Rayleigh channel.

Fig.5 shows that the performance curve obtained with QPSK for 1x2, 1x3 and 1x4 systems. The curves obtained for Rician fading channel using MRC receive diversity technique.

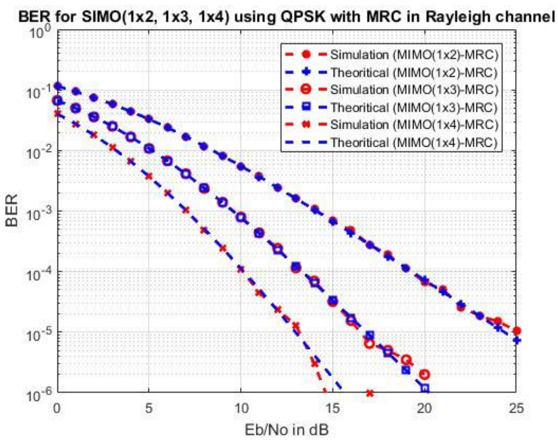

Figure 4: BER comparison for SIMO systems in presence of Rayleigh channel

systems of 2x2, 2x3 and 2x4 with QPSK technique in the presence of the Rayleigh channel.

Fig.7 shows that BER performance for MIMO systems of 2x2, 2x3 and 2x4 with QPSK technique using the Rician channel.

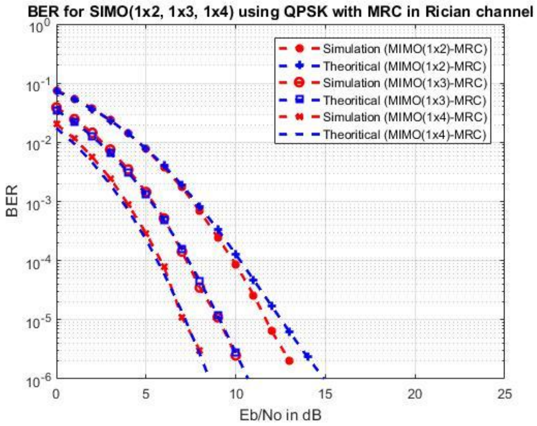

Figure 5: BER performance for SIMO systems in presence of Rician fading channel.

The BER results for MIMO systems with 2x2, 2x3 and 2x4 antenna configurations over the Weibull channel are presented in fig.8. QPSK scheme is utilized as modulation scheme. BER results of Weibull fading channel is contrasted with both Rician and Rayleigh multipath in figure 8

.

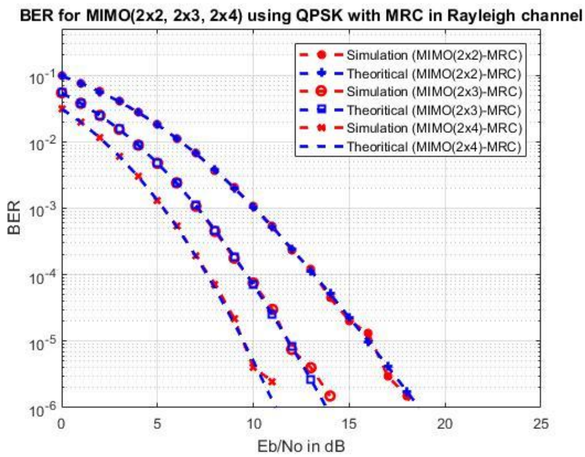

Figure 6: BER performance for MIMO systems in presence of Rayleigh fading channel.

V. CONCLUSIONS

We have structured a model for 1x2, 1x3, 1x4, 2x2, 2x3 and 2x4 MIMO systems using a QPSK modulation technique under Rayleigh, Rician and model for 2x2, 2x3 and 2x4 MIMO systems under Weibull fading channel conditions. BER is procured and compared for all systems. It has been observed that when count of antennas is increased at both transmitter side and receiver side then there is a drastic decrease in BER. High configuration antennas are the optimal solution for better BER values.

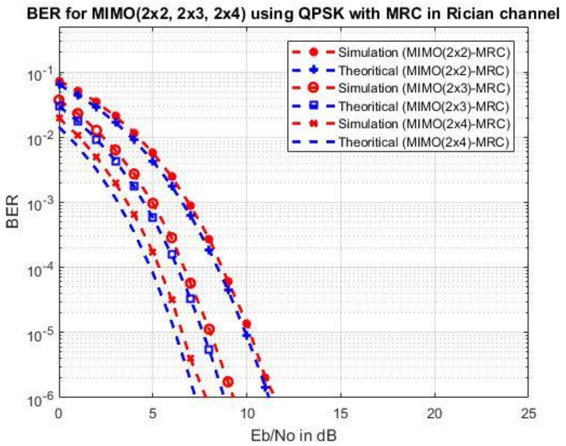

Figure 7: BER performance for MIMO systems in presence of Rician fading channel.

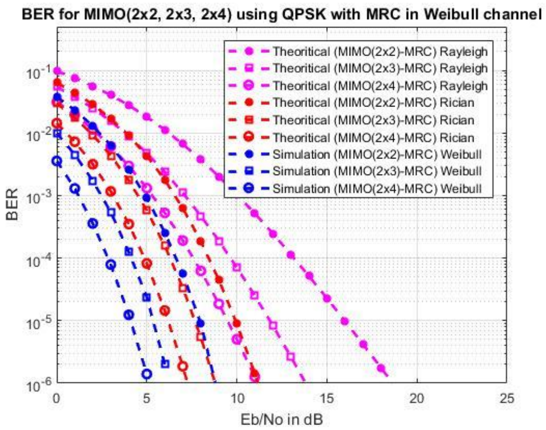

Figure 8: BER performance for MIMO systems in presence of Weibull fading channel.

REFERENCES

1. Toufik, C., Faissal, ElB., Hussain, B., "Performance Analysis of TAS/MRC based MIMO systems over Weibull Fading Channels," IEEE Conference., vol., no., pp., 2016.
2. Simon, M K, Alouini, MS., "Digital communication over Fading Channels". John Wiley & Sons, Hoboken (2005).
3. John G. Proakis, "Digital Communnications", McGraw Hill Book Co., Singapore, 2001.
4. Stefan, P., Mihajlo, S., Jelena, A., Petar, S., "Fading and Interference Mitigation in Wireless Communications". CRC Press, Taylor & Francis Group, Boca Raton (2014).
5. Faissal, El. B., Hussain, B., "Efficient Performance Evaluation for EGC, MRC and SC Receivers over Weibull Multipath Fading Channel", CROWNCOM 2015, pp. 346-357, 2015.
6. Ghrayeb, A., Duman, TM., "Performance analysis of MIMO systems with antenna selection over quasi-static fading channels", IEEE Trans. Veh. Technol., vol. 52, no. 2, pp. 281-288, Mar. 2003.
7. Lozano, A., Jinda, N., "Transmit diversity vs. spatial multiplexing in modern MIMO systems", IEEE Transactions on Wireless Communications, Vol. 9, pp. 186-197, 2010.
8. Nuzhat, TA., Mizanur, R., "Effect of AWGN & Fading (Rayleigh and Rician) channels on BER performance of a WiMAX communication System", International Journal of Computer Science and Information Security, Vol. 10, No. 8, August 2012.
9. Yahong, RZ., and Chengshan, X., "Simulation models with correct statistical properties for Rayleigh fading channels", IEEE Transactions on communications, Vol. 51, No. 6, June 2003.
10. Biglieri, E., Proakis, J., Shamai, S., "Fading channels: Information-theoretic and communications aspects", IEEE Trans. Inform. Theory, 50th anniversary issue, Oct. 1998.
11. Alamouti, S., "A simple transmit diversity technique for wireless communications", IEEE Journal on Selected Areas of Communication, Vol. 16, Issue 8, pp. 1451-1458, 1998.
12. Tarokh, HJ., Calderbank, AR., "Space time block codes from orthogonal designs", IEEE Trans. Inform. Theory, Vol. 45, Issue 5, pp. 1456-1467, 1999.

AUTHORS PROFILE

Mrs. D. Lalitha Kumarireceived her B.Tech in ECE in 2003.She has completed her Master of technology in Digital Systems And Computer Electronics in 2008..Her research interest includes wireless communication, video signal processing and digital image

Dr. M.N. Giri Prasad has been completed his PhD in 2003. He has completed is Master of Technology in Electronics & Communication Eng. in 1994, and Bachelor of Engineering in 1982. His research interest includes video signal processing and digital image processing and Biomedical Signal Processing