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Performance Comparison of Adaptive MIMO System Under Rayleigh and Rician Fading Channels

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Abstract - *The main aim of the Adaptive MIMO system is to increase the spectral efficiency by making adjustable order of the modulation based on the Fading channels. It will transmit a more number of bits depending on the channel quality. The main advantage of Adaptive MIMO is it will produce the data more efficiently and with high reliability. In this paper, the simulation for 2X2, 3X2, and 4X2 antennas with Adaptive and without Adaptive MIMO technique for Rayleigh and Rician fading channels. From simulation results, it is observed that Adaptive MIMO gives better results for 3X2 Antennas in the case of Rayleigh and Rician Fading channels.FER is observed to be 0.2013 for the Rayleigh Fading channel and is 0.2002 for the Rician Fading Channel at 8dB, so it is found that the Adaptive MIMO system is better than Non-Adaptive MIMO.*

Keywords - *snr; adaptive Mimo; fading channels; channel capacity.*

I. INTRODUCTION

In wireless communication, the Multiple Input-Multiple Output (MIMO) system will increase the functionality of the channel's capacity. The MIMO system will improve the data throughput without requiring any additional bandwidth. It consists the multiple numbers of transmitting antennas and receiving antennas for increasing the coverage area in the wireless network. In past years the Single Input–Single Output systems have been available. It consists of a single transmitting antenna and a Single receiving antenna. But, the system's speed is not suitable for high-speed applications, and it does not fulfill the requirements of demands of the user. So, forgetting the high-speed data, the multiple antenna system has been implemented. The MIMO system can produce the data at a high range. The MIMO system is represented as the communication system, consisting of the 'N' number of transmit antennas .here, the antennas are represented as 'N t,' and 'N' number of receive antennas can be represented as 'N r'. It will improve the spectral efficiency in the wirelessMIMO for increasing transmit and receive functionality at the base station. On the receiver side, the MIMO system will decrease the complexity of the Flat fading channel.

Another important technique in wireless communication is the Adaptive MIMO system. The Adaptive MIMO system has been developed recently. This system is mainly developed to fulfill the demands of the user. The Adaptive system is switching to the antenna's various transmission modes to increase the coverage and service quality. The Adaptive system is also providing some important methods like Modulation and channel varying conditions. In a Radio environment, sometimes the channels' conditions will be changing continuously, which leads to a fading problem. In these cases also the system will avoid fading and provide the proper throughput to the users.

II. BEAMFORMING

Beamforming can be called an array of signals processing the antenna direction, and this system can process radiation. This technique will follow the two conditions: one is transmitting, and another one is receiving. Beamforming will improve the receiver's sensitivity if the signal is in the state of receiving. The receiver's sensitivity can be increased in the direction of the required signal, and in the same way, the receiver's sensitivity will be decreased in the direction of the interference. Suppose the Beamforming system can improve the radiated power in the required direction if the signal is transmitting. This technology becomes very challenging for avoiding interference. Here, changes are compared in both the Transmitter and Receiver of the Omnidirectional. If the change is compared with the receiver, it is called Receiver gain, and if it is compared with the Transmitter, it is called transmitter gain. Beam forming applications are applicable for Digital computers. Beamforming can improve the data capacity, and it also provides the coverage area to the mobile systems. It is also used for transmitting and receiving in sensor arrays for getting the signal direction. Precoding is another process in wireless communication. It is the broad definition of MIMO. In the case of the single stream Beam Forming, the same signal is obtained from each transmitting antenna with proper phase and gain, so the signal's power will be increased at the input. The Beam Forming consists of some benefits. It will improve the gain of the signal received, and this process can be done by making all signals obtained from various antennas and decreasing the multipath effect. It produces the efficient directional pattern in the Line Of Sightpropagation.

III. OVERVIEW OF MIMO SYSTEM

Today, the Multiple Input-Multiple Output technique has become more popular because it increases reliability and spectral efficiency. The MIMO technique is very efficient, and it will produce the proper encoding and decoding methods.

This technique is mainly involved in two approaches. They are:

1. *Spatial multiplexing*.
2. *Space-Time block codes*.

The main advantage of the MIMO system is that it will avoid fading during the Multipath channels. In recent days, wireless communication has more demand in applications like the internet, mobiles, etc. The MIMO system also requires some gains like multiplexing, diversity, and array gain.

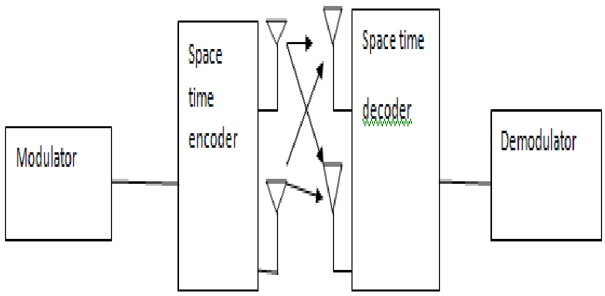

Fig1:Block diagram of MIMO

The modulator receives the input signal first, and it will modulate the given input signal, and this signal will be received by the space-time encoder, which will encode the signal.

The space-time decoder will receive this encoded signal. The decoder will decode the signal. The decoded signal will be demodulated by the demodulator and produces the output signal.

IV. DIFFERENCE BETWEEN SISO AND MIMO TECHNIQUES

A. Single Input- Single Output (SISO)

The SISO technique is very simple because the SISO has very limited functionality and requires only a single antenna for its operation. It is also called a radio channel. The below figure represents the transmitting and receiving of the single antenna system

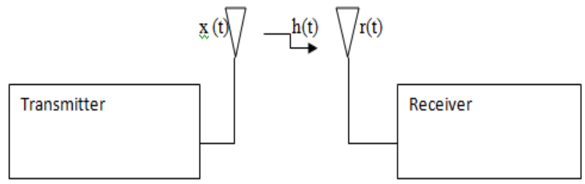

Fig2: Single Input – Single Output (SISO)

B. Multiple Input – Multiple Output:

MIMO means Multiple Input and Multiple Output system, and it requires multiple antennas at the transmitter side and multiple antennas at the receiver side. The main advantage of the MIMO technique is that it avoids Multipath fading. For suppose, during the transmission and the reception, some antennas will be affected by the fading. So, in that case, if one antenna causes a fading, then the performance can be done by another antenna. Generally, the fades will occur if there is a small change in the transmitter and the receiver.

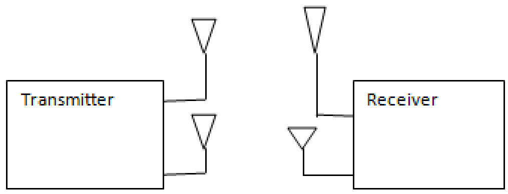

Fig3: Block diagram of multiple Input-Multiple Output.

V. MULTIPLE ANTENNA TECHNIQUES

A. Spatial Diversity

In wireless communication, Fading became a common problem. The fading is due to the fluctuations in the receiver signal if these signals are compared with the transmitted signal transmitted by the transmitter. The communication links of the radio channel will be get effected by the Multipath Fading. It can also provide some fluctuations in the radio signal. The transmitted signal will provide some replicas, and if these replicas are combined with the destructions, it will cause severe fades. Mainly, these fades will appear in space and frequency. This means if there is a change in the transmitter or receiver. Diversity is an important factor in wireless communication. It can be used to identify the changes that are occurred in time, frequency and space. Spatial diversity is one approach that can reduce the fades in; in this technique, multiple antennas are used. These antennas will improve the Quality and Reliability of a wireless link. Generally, this technique is used for avoiding Multipath propagation. The spatial diversity technique is mainly applicable to some areas which are densely populated. In these areas, the signal will not be clear, which means there is no clear line of sight between the Transmitter and Receiver. Due to this reason, the Multipath Fading will take place on the path of Transmission. So, to reduce these types of problems spatial Diversity technique has been developed. The main advantage of spatial diversity is that it contains multiple numbers of transmitting and receiving antennas. So, if one antenna experience a fade, then the process can be done by the antenna.

B. Spatial Multiplexing

The multiple antenna systems that can control the streams of data, which is inparallel is called spatial multiplexing. This method is mainly used for improving the transmission rate of the data. This method needs antenna technology. The main performance of this method is that bitstreams are divided into various data segments, and these segments will be transmitted through the various number of antennas. So, the bit rate will increase without requiring any additional bandwidth. In this method, the signal with a high rate will be divided into a small number of streams. These streams are more useful for transmitting to various receivers, and the spatial correlation will decrease method gain.

Here, the maximum rate of the 'n' number of transmitting antennas and 'n' number of receiving antennas will be calculated as ns=min (n t nr)

The main benefit of spatial multiplexing is that: Spatial Multiplexing technique needs the MIMO antenna configuration. Here a high rate signal will be converted into various lower rate streams. Each stream will be transmitted through the various transmit antennas in the same frequency channel. If these signals occur at the antenna receiver with various spatial signatures and the receiver will become accurate. It can divide these streams into parallel forms. Spatial Multiplexing will improve the channel at a high Signal Noise Ratio. The lesser number of antennas will limit the maximum number of spatial streams at the transmitter or receiver. This technique can be used without CSI at the transmitter, and if there is no CSI, this technique will be combined with pre-coding. It can also be used for simultaneous transmission to multiple receivers called Space division Multiple Access. It will make the receivers very complex. They combined with OFDM OFDMA. It can also overcome the problems very efficiently that are caused by the multipath channel.

VI. CODING DIVERSITY

Coding diversity is an important approach in wireless communication. This technique is mainly applicable in that if the transmitter does not have any information about the channel, the signal will be coded, by the space-time coding technique, forgetting the diversity of a signal. The coding diversity will fade without depending on the multiple antenna system because there is no information about the channel and the beamforming. Wireless communication can be developed by using the two methods They are:

A. Transmit Diversity.

B. Antenna Diversity

A. Transmit Diversity

Transmit Diversity can be defined as the technique which consists of the multiple numbers of transmitting antennas and the receiving antennas. One example of transmit diversity is MISO. MISO means Multiple-Input and Single output. Here, multiple antennas will be present at the transmitter side, and only a single antenna will be present at the receiver side. In this technique, the space-time codes are used for making the signal redundant. Let us consider that if S1&S2are two signals and these signals will be multiplexed into two streams, for getting the Almouti space-time block code and it can be represented in the form of:

[s1 s2] = [s1] -------- (1)

In receive diversity, at the side of the receiver, two or more antennas will be used, and at the side of the receiver, only a single antenna will be used.

SIMO is the best example of the receive diversity. SIMO means Single Input and Multiple Output. Here, only two RF paths are needed for the receiver to get the output data.

B. Antenna Diversity

Antenna Diversity is an important approach for the MIMO antenna configuration. In this technique, the signal to noise ratio. Here, the gain of the antenna will be similar to N t Nr. This can be achieved by using the number of transmit antennas. The number of transmitting antennas is called the Transmit diversity, and the number of receiving antennas is called the Receive diversity.

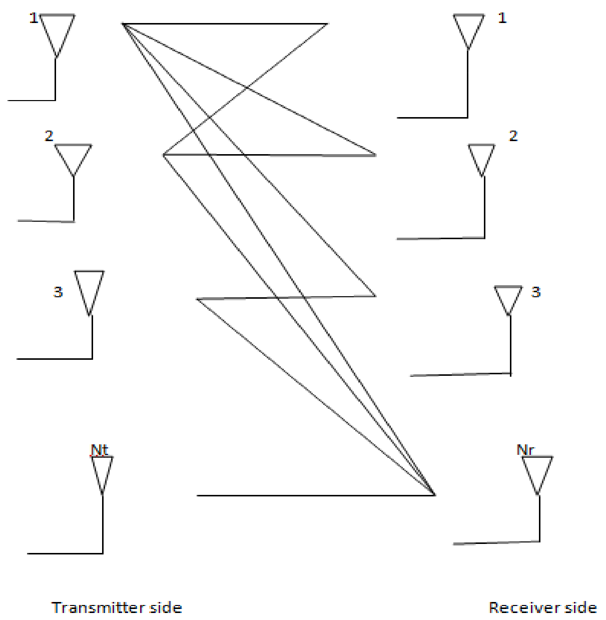

Fig 4: MIMO configuration

C. Adaptive Algorithm Modulation:

The adaption algorithm is an important component of the MIMO system. The antennas which can be transmitted or received can be depending on this algorithm. In this model, some important transmitting schemes are taking place to reduce the complexity of the system. The algorithm can produce a better tradeoff between throughputs for the lower SNR values also. In this model, the SNR value is measured for the carrier at the receiver side. The quality of the channel will vary for the various subcarriers.

The signal that is obtained from the receiver at the subcarrier can be represented as:

$R_n = H_n X_n + W_n$ ------------- (1)

Here, the coefficient of the channel is Rn

Gaussian noise is H_n

The symbol which is transmitted is Xn.

The minimum SNR values will be used in the sub-bands.

VII. ADAPTIVE MIMO AND ITS SWITCHING PERFORMANCE

It is an advanced technique in wireless communication for achieving more reliable data. Adaptive MIMO can be referred to as it is a system that has Multiple Antennas. This system can be switched to diversity techniques. Spatial Diversity and Spatial Multiplexing are involved in Multi-Antenna Technology. An adaptive MIMO system will be placed in between the spatial diversity and spatial Multiplexing based on the system's performance, channel environment, and channel conditions. Spatial diversity and Spatial Multiplexing contain their characteristic performance. An adaptive system can increase the system's performance at the maximum level. Here, the system's antenna should be set as Adaptive MIMO for measuring the effects caused by the functionality of the system's capacity. The Adaptive MIMO system obtains that. So, we can achieve data of testing for the single cell and single user at the required point.

The Adaptive MIMO has some important characteristics like:

1. The Adaptive MIMO will achieve the proper enhanced effects of capacity functionality. When compared with some diversity techniques like spatial diversity and Spatial Multiplexing, it can also increase the required throughput.
2. At the midpoint, it does not produce the proper enhancement effect of capacity performance, improving the throughput.
3. At the Far point, the data of different antennas does not improve the capacity functionality; due to this, the Throughput will be decreased.

The results of the above Throughput are not satisfied with the requirements of the demands of the users .so, and the Adaptive MIMO uses a switching technique, according to the present channel conditions. So, here two methods are used: spatial diversity and spatial multiplexing for transmitting the more reliable data. It provides the benefits of the multi-antenna methods, and it will increase the performance of the system. So, the performance of the Adaptive MIMO depends on the switching strategy.

Switching performance:

The switching performance has three important factors. They are:

1. Moving speed of the users
2. Quality of the wireless link
3. Correlation of the wireless link.

VIII.SYSTEM MODEL

The MIMO system contains nt transmit antennas, and nr receive antennas are represented in the above block diagram of MIMO. In this model, the symbols which are modulated will be received by the space-time encoder. The transmission of the symbols can be done through the Rayleigh fading channel after these symbols are received by the antenna array, which is on the receiver side. The main performance of the space-time decoder is to calculate the number of symbols that are modulated.

It can be represented as:

$Y = Es_{Hs+N}$---------- (1)

Here, Es can be represented as the energy of the modulated symbol.

N is the matrix of the white Gaussian noise.

IX. SIMULATION RESULTS

The simulation is carried out to the various number of transmitting antennas and the receiving antennas.

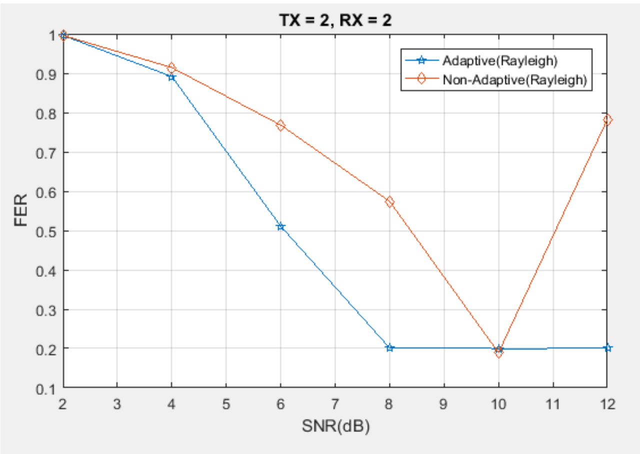

Fig 5: FER comparison for Adaptive and Non-Adaptive Multiple Input- Multiple Output system under Rayleigh fading and with (NT= 2, NR=2) for QPSK.

Fig 5 represents the 2X2 antenna system FER observed for Adaptive MIMO system is 0.2013 and is 0.5741 for Non-Adaptive MIMO system at8db under Rayleigh fading channel.

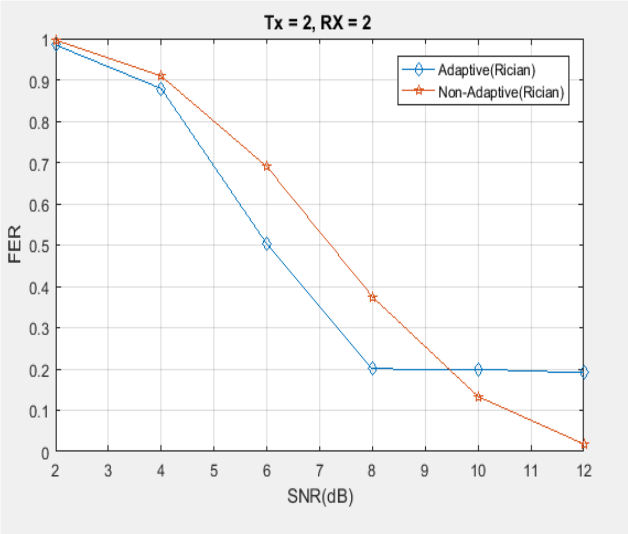

Fig 6:FER comparison for Adaptive and Non- Adaptive Multiple Input-Multiple output system under Rician fading channels and with NT= 2, NR=2) For QPSK.

Fig 6 represents the 2x2 antenna system. Here, the FER observed to be 0.2002 for the Adaptive MIMO system and is 0.3745 for Non- Adaptive system under the Rician channel fading condition

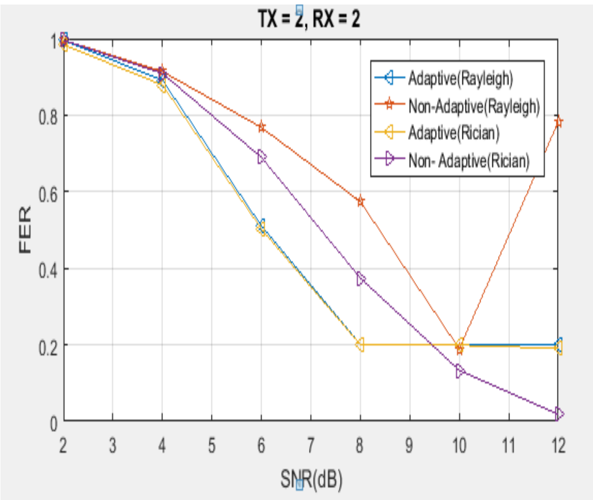

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Fig7: FER comparison of both Adaptive and Non-adaptive Multiple Input- Multiple Output system under Rayleigh &Rician fading channels with (NT=2, NR=2) for QPSK.

Fig 7 represents the Two Transmit – Two Receive antenna system. Here, The FER observed is 0.2013 for the Adaptive MIMO system and is 0.5741 for the Non- Adaptive MIMO system in the case of the Rayleigh Fading channel condition. Similarly, FER observed is 0.2002for the Adaptive MIMO system and is 0.3745 for the Non-Adaptive MIMO system under the Rician channel fading channel.

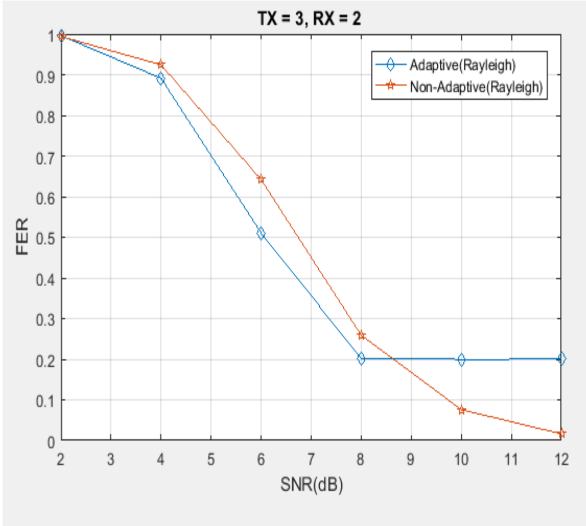

Fig 8: FER comparison for Adaptive and Non-Adaptive Multiple Input –Multiple Output system under Rayleigh fading channel and with (NT= 3, NR=2) for QPSK.

Fig 8 represents the Three Transmit and two receive antenna systems. Here, the FER observed is 0.2013for the Adaptive MIMO System and is 0.2591for the Non- Adaptive MIMO System, in the case of the Rayleigh Fading channel.

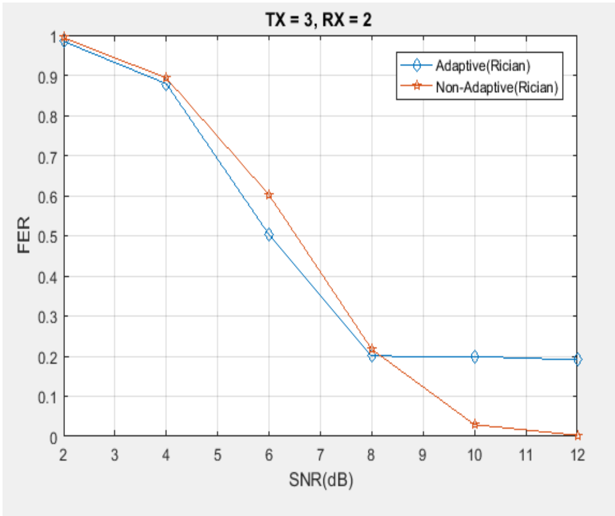

Fig9: FER comparison for Adaptive and Non- Adaptive Multiple Input- Multiple Output system under Rician fading channel and with (NT=3, NR=2) for QPSK.

Fig 9 represents the Three Transmit and two receive antenna systems. Here, the FER observed is 0.2002 for the Adaptive MIMO System and is 0.2169 for the Non-Adaptive MIMO System, in the case of the Rician Fading channel.

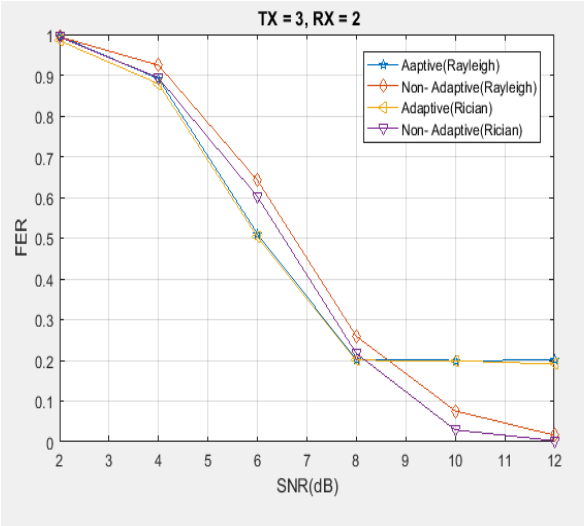

Fig 10: FER comparison of both Adaptive and Non-adaptive MultipleInput-Multiple Output systems under Rayleigh & Rician fading channels with (NT=3, NR=2) for QPSK.

Fig 10 represents the Three Transmit – Two Receive antenna system. Here, The FER observed is 0.2013 for the Adaptive MIMO system and is 0.2591 for the Non- Adaptive MIMO system in the case of the Rayleigh Fading channel condition.

Similarly, FER observed is 0.2002 for the Adaptive MIMO system and is 0.2106 for the Non-Adaptive MIMO system under Rician channel fading.

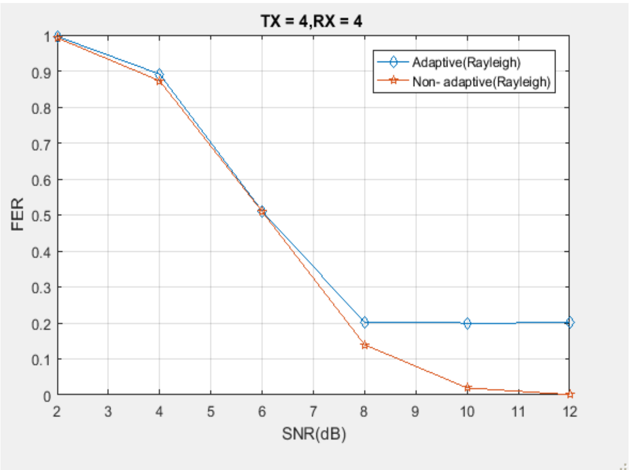

Fig 11: FER comparison for Adaptive and Non-Adaptive Multiple Input-Multiple Output system under Rayleigh fading channel and with (NT= 4, NR=4) for QPSK.

Fig11: represents the Four Transmit and Four receive antenna system. Here, the FER observed is 0.2013 for the Adaptive MIMO System and is 0.1394 for the Non-Adaptive MIMO System, in the case of the Rayleigh Fading channel at 8dB.

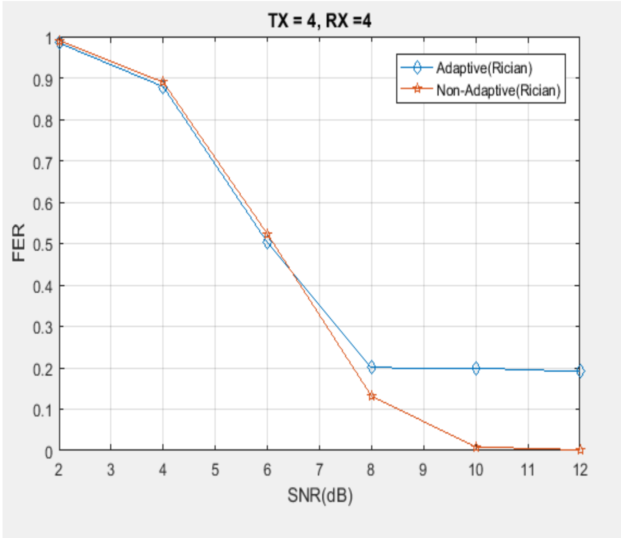

Fig12: FER comparison for Adaptive and Non-Adaptive Multiple Input- Multiple output system under Rayleigh fading channel and with (NT= 4, NR=4) for QPSK.

Fig 12 represents the Four Transmit and four receive antenna systems. Here, the FER observed is 0.2002 for the Adaptive MIMO System, and is0.1312 for the Non-Adaptive MIMO System, in the case of the Rician Fading channel at 8dB.

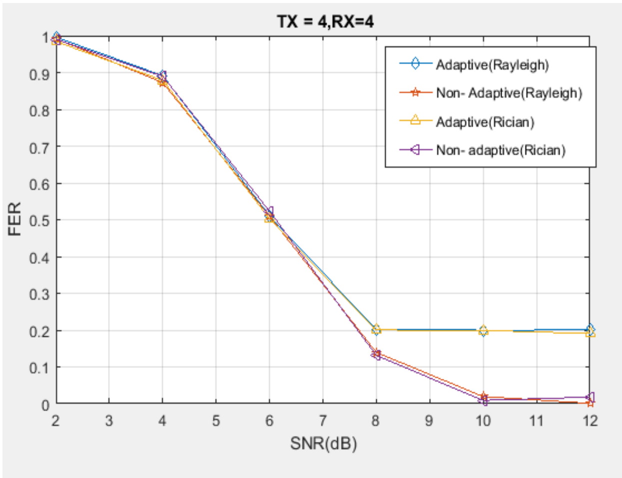

Fig 13: FER comparison of both Adaptive and Non-adaptive MultipleInput-Multiple Output under Rayleigh&Ricianfading channels with (NT=40, NR=4) for QPSK.

Fig13 represents the Four Transmit and four receive antenna systems. The simulation is carried out for both the Adaptive and Non – Adaptive MIMO systems. The FER observed is 0.2013 for the Adaptive MIMO System, and is 0.1394 for the Non- Adaptive MIMO System, in the case of Rayleigh Fading channel, and in the same way, it is observed that 0.2002for Adaptive MIMO System, and is0.1312 for the Non- Adaptive MIMO System at 8dB.

X. CONCLUSION

Adaptive Modulation schemes for both transmission systems with MIMO under Rayleigh and RicianFading channel conditions are described in this paper. The Frame error rate transmitted signal in the Adaptive MIMO System shows the Minimum results than the Adaptive MIMO System. Simulation is carried out for the various number of Transmitting antennas and the Receiving antennas. On comparing all the results, it is observed that Frame error rate and Signal to Noise Ratio can be achieved at 8dB for the 3 X 2 antennas is 0.2013 and 0.2002, in the case of Rayleigh and Rician Fading channels.

In Adaptive Modulation, the Modulation rate changes based upon the value of an instantaneous SNR. The FER performance Comparison between Adaptive and Non-Adaptive Modulation shows the FER performance for Adaptive MIMO is better than Non- Adaptive MIMO.

REFERENCES

[1] Antonio Forenza, Member Ieee, Matthew, R.Mckay, student, MemberIeee, Ashishpandharipande, Member Ieee, RobertW.Heath.Jr, senior Member, Ieee, Adaptive MIMO Transmission for Exploiting the capacity of the spatially correlated channels, Ieee conference on Transactions on vehicular Technology 56(2) (2007).

[2] Angel Lozano, Niharjindal member IEEE, Transmit Diversity vs. Spatial multiplexing in Modern MIMO systems 9(1) (2011) 186-197.

[3] Muhammad Usman Sheikh RafalJaguL, performance Evaluation of AdaptiveMIMOswitching in Long TermEvaluatio, IEEE conference, 9781-4244-9538-2/11, (2011).

[4] Mohammad ZSiam and Marwankrunz, University Arizona' An Overview of MIMO Oriented Channel Access in Wireless Networks, Ieee Wireless communication, February 2008.

[5] Mayurv. Ambagade, Ms.DivyaDhawan, performance analysis of Adaptive MIMO OFDM system., Recent and innovation trends in computing&communication, 3(5) (2015) 3394-3399[3].

[6] Jallal Elshabrawy and Sally Nafie, German university in cairo, An Adaptive MIMO system using Incremental diversity.

[7] Sudha Arvind, Dr.V.D.mytri, design of Simulink model for ost bc and performance evaluation of ieee802.16 of dmphy link and without space-time block coding for wireless communication, (IJERA), NCDATES(09-10 January 2015), ISSN:2248-9622

[8] Ch.Tidula, M.tech student, department of ECE, Ch. Santhi Rani professor and head of the department Ece Adaptive MIMO System with OSTBC using SpatialDiversity and spatial multiplexing, Icrcet 3rd international conference on Tirupati , Ijerece, 4 (2017).

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