ABSTRACT

MIMO playsa momentous Role in fourth generation Wireless technology. This technology is being perpetually used in designing of a no. of rapidly frowning Cost effective and reliable systems. As MIMO stand for MULTIPLE INPUT & MULTIPLE OUTPUT, so no of input (No. of Rx.) and No: of output (No. of tx.) also plays a vital role in designing of efficient system. In this Paper we will mostly work with effect of No. of Transmitters and Receivers on selection of detection schemes.

KEYWORDS: MIMO, Transmission Channels, QAM-8bit, QAM-16bit, QAM-32bit

CHAPTER-1

INTRODUCTION

1.1 BASIC IDEA

In the present scenario, the most vital part of human life is „Communication" and the technologies in communication world are reaching the height where humans have thought to be. Among all the techniques, „Wireless Communication" has catered better performance than all others and currently it's the renowned way to communicate. This has shortened the area of communication and every distant place is now in easy reach of all. Since many years of research, the capabilities of wireless LAN and cellular mobile system have fully fledged exclusively. Contrasting to the data rates accessible by the present technologies specifically in wireless internet access and multimedia appliances need to emanate performance criterion with respect to the magnitude. Usage of multiple antennas at the transmitters and the receivers, have led to the increment in the data rate in the system. The most significant and advanced prospect of technologies in mobile radio communication is multiple antenna elements which are located at the transmitter and at the receiver.

According to most of the researches done in the area of wireless communication had laid its focus on the usage of an antenna array but only at single end of the wireless link i.e. at the receiver. More often at base stations „Receive diversity" has find its usage in establishment of communication systems. Let's see an example to comprehend this. „GSM" generally known as Global System for Mobile communication base station usually have two receive antennas. Application of this advance technology has improvised the performance structure and provided a better quality of uplink going from mobile to base station. And this has achieved on absolute no cost or size or consumption of power to the mobile. Many researchers have also revealed that the achievement of transmit diversity can occur by using multiple antennas at transmitter end. This has led to many reimbursements and also a considerable quantity of gain in result of receives diversity. The development of transmit diversity technique commenced in the beginning of 1990"s. Multiple-Input Multiple-Output (MIMO) technology turned out to be as a foundation stone of several wireless communication systems. And this is the result of the impending augment in the data rates as well as operation of wireless links which are accessible by MIMO technology and transmit diversity. The outstanding proposal hidden behind the MIMO is that the

receiver antennas at one closing stage and the transmit antennas at other closing stage are linked and collective in such a manner that the excellence (the bit error rate- BER) have improved a lot for every user.

The efficient power of computation in integrated circuits and a corresponding enhancement have catered an easier way of feasibly implementing MIMO system. It has signal processing algorithms associated with it. The figure shown below embodies a MIMO wireless communication system which encloses manifold antennas at both the transmitter and the receiver.

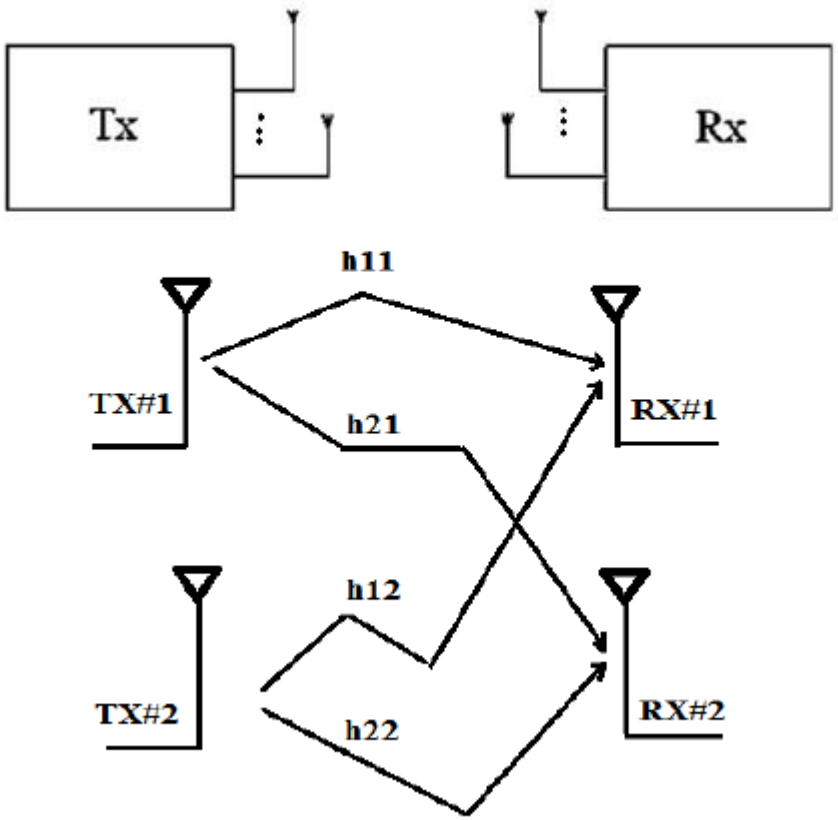

Figure 1.1:- MIMO communication system

The cellular network implementation which is predominant is enabled to with stand a single antenna on mobile device and having multiple antennas at the foot station. This results into diminution in the expenditure of the mobile radio to a much extent. Taking another side of when the expenses on other radio frequency apparatus in mobile devices are negotiated or

compensated, then the other antenna in mobile devices develop into more efficient enough to access on. Taking view of latest cellular phones, laptops and other communication devices encloses two or more antennas. Recently, the newest technologies in the market of communication world are 3G and 4G and MIMO is designed to be used in mobile radio telephone standards. This has led to not just a noteworthy increase in spectral efficiency but has also improvised the reception operation. It also consents to a superior reach and rate of transmission. In fact all forthcoming 4G systems will also make use of MIMO technology. The downside of the wireless channel which obstructs the performance is fading. This happens when the signal pursues multiple paths between transmitted and the received antennas. At some circumstances, the arriving signals add together antagonistically and thus, dropping the received power to zero or nearly zero. No consistent communication is possible here. The problem of fading can be diminished by diversity. This means that the information or data which is transmitted not only one time but numerous times assuming that at least one of the imitation signal will not with stand stern fading. There are some vital characteristics of wireless MIMO channels which are sufficiently used by diversity. They are such as: the various signal paths can be frequently replica of a number of detach and self-governing fading channels. These are divergent in time domain or frequency domain.

1.2 MODULATION METHODS

Modulation is defined as the process where information or data is supplemented to the radio carrier. This occurs when the data services like wireless multimedia is to be shore up. Digital modulation improvises on the spectral efficiency. This is because the digital signals are more vigorous in opposition to channel impairments. Achievement of superior spectral efficiency can be done by the modulation scheme which has higher bandwidth efficiency. The units are bits per seconds per hertz of bandwidth. This must be chosen cautiously. The preference of a modulation scheme depends upon the subsequent characteristics.

1.2.1 COMPRESSED POWER DENSITY SPECTRUM

The power to be dissipated adjacent channel must be 60-80 dB below that in the desired channel. This lessens the effect of adjacent channel interference. Therefore, modulation schemes which have slender main lobe and swift roll off of side lobes are advantageous.

1.2.2 SUPERIOR BIT ERROR RATE PERFORMANCE

It shows low bit error rate possibility even when co-channel interference is present. Channel impairments like fading and inter symbol interference (ISI), adjacent channel intrusion and thermal noise are reduced too much extent.

1.2.3 ENVELOPE CHARACTERISTICS

To overcome reproduction of spectral side lobes, the input signals should have a moderately invariable envelope for the duration of nonlinear intensification.
In electronics and telecommunications, modulation is the procedural to fluctuate several characteristics of a periodic waveform, called the carrier signal, with a signal which fluctuates that solely accumulates the information needed to be transmitted. In branch of telecommunications, modulation is the phenomenon to convey a signal carrying any information, for an illustration a bit stream of digital or an analog audio signal, in a different signal which can be relayed physically. A sine wave's modulation transfigures a baseband message signal into a pass band signal. A modulator is a device that performs modulation.
A demodulator (sometimes detector or démodé) is a device that performs demodulation, the inverse of modulation. A modem (from modulator–demodulator) can perform both operations. The aim of analog modulation is to transfer an analog baseband signal, for an illustration an audio or TV signal, by a pass of analog band channel at a various frequencies, for an instance over a minimal band of frequency of radio or a channel of cable TV network. The goal of digital modulation is to transfer a digital bit stream over an analog band pass channel, for example over the public switched telephone network (where abandpass filter limits the frequency range to 300–3400 Hz) or over a minimal band of frequency of radio. Digital & analog modulation facilitate frequency division multiplexing (FDM), where several low pass signals of information are transported simultaneously over the identical sharable mechanism , using different pass band channels (several different carrier frequencies).

The aim of digital baseband modulation methods, also known as line coding, is to transport a stream of bits which are digital atop a stream of baseband, solely a copper wire which is not strained like a serial bus or a wired local area network. The aim of pulse modulation methods is to transfer a narrowband analog signal, for example a phone call over a wideband baseband stream or in some scenarios as stream of bit over another digital transmission system. I Systems which produce music, waveforms may be generated using such synthesizers with a substantial spectrum which is overtone by making use of less number of oscillators. In this scenario the frequency of carrier wave is quintessentially in the identical order or minimized than the modulating waveform.

1.3 DIGITAL MODULATION METHOD

A signal for carrier which is analog is modulated by a disjunction of signal in digital modulation. Digital methodologies for modulation can be taken into account as manipulation from digital to analog & the adjoining demodulation or recognition as manipulation from analog to digital. The modifications in signal of carrier wave are picked up from a defined number of M variegated symbols.

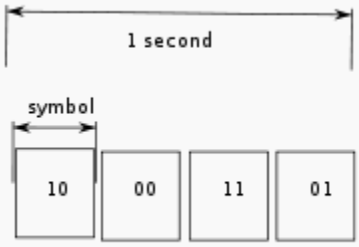

Figure 1.2:- Digital modulation method

Schema of 4 baud (8 bit/s) link of data contains selected arbitrarily values.

A simple example: The design of a telephone line is structurized in that way to solve the purpose to transfer sounds which can be listened, for example tones & not digital bits. Computers might transfer information over a thread of telephone by modems, which represent the tones formulated by digital bits referred as symbols. If there are four substitutes for symbols which corresponds to a musical instrument that can produce four non identical tones each an instance, the sequence of bits for 1st symbol may be presented as sequence of 00, the 2nd one as 01, the third as 10 & the

fourth one as 11. If a melody is being played by the modem which comprise of 1000 tones per second, the symbol rate is 1000 symbols/second, or baud. Since every single tone that presents a piece of information comprised of two digital bits, the bit rate is two times the rate of symbol which means 2000 bits per second. This is the same which is used in dialup modems in opposition to DSL modems.

According to one definition of digital signal, the modulated signal is a digital signal. By a different explanation, the modulation such type of digital-to-analog transformation. Many books will take the schema of digital modulation as just like digital relay, synonymous to data relay; only a minimal number of them would take it as analog transmission.

1.4 PSK (PHASE SHIFT KEY)

1.4.1 PHASE-SHIFT KEYING (PSK)

Is a digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal?

Any digital modulation scheme uses a finite number of variegated signals to piece of information which is digital. PSK makes use of finite quant of phases; each allocated by a distinctive pattern of binary. Generally each phase is encoded by bits identical in quantity. A symbol is formulated by print of bits that is represented by the particular phase. The demodulator that is solely for the set of symbols needed by modulator examines the phase of the signals which were received & prints it again to the symbol it visualizes, thus recuperating the actual information. The receiver is needed to collate the reference signal's phase to received signal — and this type of system is referred as coherent. On the other side rather than that of operation with reference of stable wave, the operation of broadcasting cans e done by self. Manipulations in condition of waveform of only broadcast can be taken in account as the magnificent items. In such system manipulations in the section of the signal which is received but not the phase itself are formulated by demodulator. As dependence of this schema relies on differentiation between conjugating phases, it is referred as keying of differential phase-shift. DPSK can magnificently be uncomplicated to implement than basic PSK as the demodulator to produce a Xerox of signal of reference to evaluate the

exact phase of the signal received is not required. In return, it generates more erroneous demodulation.

1.4.1.1 INTRODUCTION

There are three major classes of digital modulation techniques used for transmission of digitally represented data:

- Amplitude-shift keying (ASK)
- Frequency-shift keying (FSK)
- Phase-shift keying (PSK)

All transmits data by manipulating some fundamentals of a base signal, the wave for carrier, in retaliation to a signal of data. In the scenario of PSK, the phase is formulated to visualize the of data. There are two standard techniques to utilize the signal's phase in such way:

- By visualizing the phase by self as transferring the information, in which case the demodulator must have a signal of reference to contrast the phase of received signal against; or
- By viewing the change in the phase as conveying information — differential schemes, some of which do not require a carrier as reference.

A technique which gives an ease to present PSK schema lies on a constellation diagram. This shows the points in the complex plane where, in this context, the real and imaginary axes are referred to be in-phase & axes of quadrature as per their their 90° separation. This type of presentation on axes which are perpendicular tends itself to implementation in straightforward direction. The every point's amplitude along the in-phase axis is required to modulate a wave of cosine & the amplitude by the axis of quadrature to modulate a wave of sine. By convention, cosine is of in-phase modulates & sine is of quadrature modulates.

In PSK, the points of constellation which are selected are usually positioned with uniform angular spacing around a circle. This provides the extreme distinction of phase among adjacent nodes & thus the best prevention to graft. As they can all eit the same range of frequency, they are placed in the shape of a circle. Thus, the modulus of the numbers which are complex, their representation will be identical & thus amplitude which is required for cosine &

sine waves. Two basic illustrations are binary phase-shift keying which makes use of two phases & quadrature phase-shift keying which makes use of four phases, though use of as many phases can be made as per wish. Since the data to be transmitted is usually binary of nature, the schema of PSK is usually structurized with the quant of points of constellation of power of 2.

1.4.1.2 APPLICATIONS

Tending towards simplicity of PSK, particularly when it is put in contrast with its opponent's modulation of amplitude of quadrature, its use is majorly taken in existing technologies.

The LAN standard which is wireless, IEEE 802.11b-1999, uses a variegated type of different PSKs relying on the rate of data needed. At standard rate of 1 Mbit/s, it makes use of DBPSK. To deploy the enhanced rate of 2 Mbit/s, DQPSK is needed. On attaining speed of 5.5 Mbit/s & the overall rate of 11 Mbit/s, ploy of QPSK is done, but needs to be amalgamated with complementary keying of code. The enhanced speed of standard of LAN which is wireless, IEEE 802.11g 2003 comprises of eight data rates: 6, 9, 12, 18, 24, 36 & 48 & 54 Mbit/s. The modes of 6 & 9 Mbit/s use OFDM modulation where each sub part of carrier is modulated by BPSK. The modes of 12 & 18 Mbit/s make use of OFDM along with QPSK. The rapid four schemas make use of OFDM along with forms of quadrature modulation of amplitude.

Just by simplicity of it BPSK is suited for transmitters with low-cost pass, & is required in RFID standards such as ISO/IEC 14443 which has been adopted for biometric passports, credit cards such as American Express's Express Pay, and many other applications. Bluetooth 2 will use $\pi/4$-DQPSK at its nadir rate of 2 Mbit/s & 8-DPSK at its higher rate of 3 Mbit/s when the connection in two devices is enough to robust. Bluetooth 1 modulates with keying of minimum shift of Gauss that is a binary schema so one of the choices of modulation in version 2 will produce an enhanced rate of data. A somewhat same technology, IEEE 802.15.4 (the wireless standard used by Sigsbee) also relies on PSK. IEEE 802.15.4 permits to make the use of bands of two frequency: 868–915 MHz using BPSK and at 2.4 GHz my making use of OQPSK.

Both 8PSK & QPSK are majorly required in transmission of satellite. Still major use of QPSK is in streaming of satellite SD programs & some HD programs. HD programs are relayed almost solely in 8PSK because of the higher rate of bits of videos in HD & the enormous price of bandwidth of satellite. The criteria of DVB-S2 need assistance for both 8PSK & QPSK. The sets

of chips which are needed in set top boxes of new satellite like Broadcom's 7000 series assistance 8PSK & are compatible backwardly with the conventional criterion.

1.4.2 BINARY PHASE SHIFT KEY

BPSK is the easiest type of keying of phase shift. It makes use of two sections which are distinguished by 180° & can also be referred as 2-PSK. It really doesn't bother at all exactly where the points of constellation are located & in this diagram they are presented on the real axis at 0° & 180°. This modulation is the maximum robust of all PSKs as it absorbs the level of maximization of noise or distortion to tend to make demodulator a false judgment. But it is able to modulate only at 1 bit/symbol & so is not appropriate for applications for high rate of data. As if a arbitrary shift of phase is present there which is launched by channel of communication, the demodulator can't identify the point of constellation. By this outcome the data is often differentially encoded prior to modulation.

BPSK is functionally equivalent to 2-QAM modulation.

1.4.3 QPSK (QUADRANT PHASE SHIFT KEY)

Sometimes this is known as quadriphase PSK, 4-QAM, 4-PSK. Though the elementary concepts of QPSK & 4-QAM are not the same, the out produced modulated waves of radio are identical. QPSK makes use of four points on structure of constellation, given an equal space on boundary of a circle. By four phases, encryption of QPSK by two bits per symbol with Gray to minimize the bit error rate (BER) — sometimes misinterpreted as two times the BER of BPSK.

The mathematical interpretations presents that use of QPSK can be used either made to make the rate of data twice when put in contrast with a BPSK system while prolonging the same bandwidth of signal, or to prolonge the rate of data of BPSK but halving the required bandwidth. In this case later, the BER of QPSK is identical to the BER of BPSK - and determining differently is a basic indecision when determining or describing QPSK. The relayed carrier can undergo quantity of modifications in phase.

Provided that channels of communication on radio are deployed by divisions such as the Commission of Federal Communication allocates a prescribed bandwidth, the superiority of QPSK over BPSK becomes un-changeable: QPSK relays two times the rate of data in the

provided bandwidth in contrast to the BPSK - at identical BER. The fine of engineers that is levied is that transmitters of QPSK & receivers are more baffled than those of BPSK. On other side with modern electronics technology, the fine of penalty is very minimal. Along BPSK, there are several complications in ambiguity of phase at the side of receiver, and differentially encoded QPSK is often used in practice.

1.4.4 DIFFERENTIAL PHASE SHIFT KEY (DPSK)

DPSK is a standard format for modulation of phase that relays information by fluctuating the carrier wave's phase. As described for BPSK & QPSK there is a state of ambivalence of phase as constellation is rotated by an effect somewhat in channel of communications by which the signal transfers. This problem can be overcastted by making use of data to manipulate rather but not setting the phase.

As an illustration, in BPSK which is encoded differentially a '1' which is binary may be transferred by summing up 180° to current phase & a '0' which is binary by adding 0° to the current phase. Another formulation of DPSK is keying of Symmetric Differential Phase Shift, SDPSK, where encoding is generally +90° for a '1' and −90° to '0'.

In DQPSK, the shifts of phase are 0°, 90°, 180°, −90° which corresponds to data '00', '11', '01', '10'. Such sort of encoding might be demodulated in the way identical to non-differential PSK but the ambivalence of phase can be disregarded. Thus, every symbol which is received is demodulated to either one of points of M in the constellation and a comparator then calculates the phase difference between this signal received & the one which is proceeding. The data is encrypted by the codes as mentioned above. SDQPSK is also similar to that of DQPSK, but standards to encode are similar, using figures of shift of phase −135°, −45°, +45° and +135°.

The signal which is modulated is presented below for both DQPSK & DBPSK as explained above. In the diagram, it is presumed that commence of signal is with phase zero, and thus there is a shift of phase in both of the signals at $t = 0$.

1.5 OUTLINE OF THE DISSERTATION

Here there is a draw round of the intact Dissertation and research work:

Chapter 2 tells how one can have a concise literature survey on MIMO System and various diverse detection schemes.

While undergoing Chapter 3; a proposal is provided concerning properties, channel properties, channel capability, SNR and fading of channel must be handled in MIMO wireless system. Coming to Chapter 4, it gives the description of diverse detection schemes which includes their properties and arithmetical modeling and also ML, ZF, MMSE (also using SIC) and QR Decomposition etc.

Chapter 5 contains the complete vindication of Quadrature Amplitude Modulation Scheme. This incorporates arithmetical expressions and derivations, generation, detection, error probabilities and various other pros and cons.

Chapter 6 deals with Simulation outcomes and the parameters which are used in simulating the design code down with their assessment with various other detection techniques.

Finally, Chapter 7 wrap ups the whole research work and directs the bright way to future implementations as well.

CHAPTER 2
LITERATURE SURVEY

The fine work of winters [1], Foschini and Gans [2], and Telstar [3] [4] led to the major evolution of MIMO System. The advantages of making use of manifold antennas by the exploitation of signal diversity proffered by multipath effect; is so efficiently illustrated in their work. MIMO System has proposed a very high spectral efficiency. The implementation of Multiplexing can also be done over here. This can be accomplished by connecting multiple antennas in parallel. But this should be done in such a way that multiple data streams are adept to be transmitted at the same time. And the outcome will be an amplified data rate. It is often require a proficient and equipped knowledge of the channel conditions to attain these types of spectral efficiency improvements. This is embodied by the channel matrix. There are a plenty of technical hurdles which arise in the design of robust and fast wireless systems; nevertheless, it still offers better functioning which is essential to hold up many developed applications. This has only been made possible due to MIMO being frequency selective, power-limited and also susceptible to the noise nature of the channel. The consistent transmission entails ciphers to be successfully and flawlessly retrieved at the receiving edge. For a specific channel in coded MIMO system, the best soft decoder used for the minimization of the BER is usually the maximum-likelihood (ML) detector [5]. On the contrary, the foremost shortcoming spurts up in the detection process is that it sometimes turn out to be extremely complicated because of its complex design. This leads to an exponential increment with escalate number of transmitting antennas at the transmitter and also directly proportional to its order.

The previously erroneous detected symbols [7] can be balanced and a contemporary detection scheme has been initiated which outdo the prior MMSE V–BLAST detector. But this is particularly for channel coded MIMO architecture. This has to be done in such a manner that by

making use of just one matrix inverse, detection of each transmitted symbol vector is done. Many researchers have been conducted in the science world and have stepped down to the conclusion that spatial diversity supplied by multi-antennas to transmit and receive data, which permits a significant enhancement in the capacity of wireless communications systems. A survey conducted on „MIMO-Systems" turned out to be extremely skilful and knowledgeable. The plethora of views and ideas of intellectual and professionally and technically qualified people from around the globe enhanced the concepts and made them so unproblematic to be understood. The brushed up new techniques and the meticulous works of these technicians caters a platform where one can learn more and more in the integral aura of the technical world. This survey brings out the uphill hard work and one can gain a lot from their experiences. Let's read on what the survey extracts out.

[1] **In 2013, Juhi Garg, Kapil Gupta, P. K. Ghosh," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering *Vol. 2, Issue 4, April 2013* Performance Analysis of MIMO WirelessCommunications over Fading Channels – A Review,"**Multiple Input Multiple Output (MIMO) technology uses multiple antennas at the both link ends and does not need to increase additional transmit power and spectrum, leading to promising link capacity gains of several-fold increase in spectrum efficiency. Increased capacity can be achieved by introducing additional spatial channels that are exploited by using coding such as space-time coding (STC). The spatial diversity improves the link reliability by reducing the adverse effects of link fading and shadowing. In this article, we survey environmental factors that affect MIMO capacity. These include channel complexity, external interferences, and channel estimation errors. With the use of MIMO communication techniques, multipath need not be a hindrance and can be exploited to increase potential data rates and simultaneously improve robustness of the wireless links. This review article provides a detailed explanation of MIMO technology and explains how such benefits can be achieved using this technological breakthrough. There has been an abrupt raise in the call of services of mobiles in the last few years and various conveyers of mobile have faced even more proportion of growth. According to a recent forecast, the traffic of mobile data is presumed to become almost each succeeding year through 2014, which leads to overall compound yearly proportion of growth of around 100%. Within the range of system development, LTE-Advanced and WiMAX - 2 can use up to 8x8

MIMO. Additionally new signals of reference have been lime lighted to provide support to demodulation/ detection and channel state information estimation. Hence, special attention has been paid to the signaling for more advanced SU/MU-MIMO schemes. However, the crucial sensitivity of MIMO receivers to channel interference is the key challenges faced in cellular networks with the use of MIMO technology. On one hand, system designs should reduce transmits power and data rate in order to suppress the interference caused to the adjoining cells. Apart from this, systems based on MIMO by nature Increases the quant of data relayed & thus needs a greater received signal to interference noise power ration (SINR). Advanced signal processing methodologies at the transmitter & receiver as meaning of minimizing or cancelling the interference effects have been used. Thus, with the help of this article, we found that MIMO system is nothing but the use of multiple antennas at both transmitter and receiver. This is used to improve the link reliability and data throughput without additional bandwidth and transmit power. Multi-user MIMO and single-user MIMO are the two main forms of MIMO with processing such as pre-coding, diversity coding and special multiplexing. Reconfigurable antennas have been used to achieve pattern and frequency diversity in MIMO. The given article has represented many of these methodologies suffer from many practical drawbacks in reference to complexity & required information about channel and make an application which is successful with respect to 3G cellular appliances.

[2] **In Lian Zhao, Hari Shankar, Ariel Nachum ,” 40G QPSK and DQPSK Modulation,”** This documents elaborates the thesis that works on the back of differential phase shift keying & differential of quadrature phase shift modulation formats and gives a detail elaboration about how to enact a DQPSK set-up of experiments, using in phi’s 2514DZ differential Mach-Zender (MZ) driver. Multi-level modulation techniques permits for systems to transport higher rates of bits in wavelength which is spaced densely division multiplexed channels. 40G DQPSK & 100G DP-QPSK are exhibiting answers to problems for long haul transportation with enhanced tolerance to pair such as Chromatic Dispersion & PMD, and efficiency of enhanced spectral. The improved accessibility of components in market is generation of this complex DQPSK solution as possible.

[3] **In Rao Farhat Masood,” Adaptive Modulation (QPSK, QAM),”** This document introduces the notions of digital modulation requires in many systems for communication these days. The presented techniques comprise of keying of quadrature phase shift & modulation of quadrature amplitude and how the capacity & speed of a wireless channel can be enhanced by making use of such techniques. These methodologies on modulation are the fundamental criteria of systems for communications such as cable modems, DSL modems, CDMA, 3G, Wi-Fi* &WiMAX*. Both QPSK & QAM are modulation approaches required in IEEE 802.11, IEEE 802.16 & 3G technologies for wireless. The signals which were modulated are later demodulated on receiver’s end where the actual which is in digital format can be recuperated. The frequent use of modulation which can be remodeled permits wireless approaches to optimize outcomes, cultivating higher quantity while parallel covering large distances as well.

[4] The wireless communication systems have went through various peer groups from framework of SISO to MIMO. One major curb that occur in wireless communication is Bandwidth. Much greater rate of transference of data is cardinally required in wireless transmission like data, video & voice. The capacity is the major factor that justifies its quality on the user side. This goal of this document is to contrast various wireless communication systems of RF just like SISO, MISO, MIMO & SIMO based on the criteria of capacity & explaining the fact that the evolution of technology of wireless has raised as 2G, 3G to 4G & the companies are struggling to enhance the capacity of the network so rate of data can be enhanced and more customers can be comforted. The final goal of the system of wireless is to develop a global multimedia & personal communication without any issue of capacity.The channel of MIMO presents the utmost roomtheoretically which has also been confined by simulation. Also with the extension of antennas for purpose of receiving and transmission has extended in channels of MIMO there room also increases by the green line as represented in figure. Also the variegated systems like SISO, SIMO, and MIMO & MISO are studied till complete to give a base for the fresh researchers to accumulate their research in this area.

[5] An extensive use of FSK is for the purpose to the information over channels of pass band because it can simply be applied without making no use of any detection scheme which is coherent. Enhanced execution of BER can attained with synchronization of précised phase using

detection Scheme which is coherent. By making use of transfigure of fast Fourier, the detected based on spectrum can be applied: complex sinusoid & complex square wave. The execution of BER is slightly lower than systematic detection. Unlike the systematic detection, synchronization of phase is not explanatory for the observation based on spectrum. With furtherance by making use of observation based on detection complex square wave as the multipliers are not necessarily needed there can be attained easily. Simulation is performed in the present additive white Gaussian noise based on Equation (I). A random phase terms is included in the simulation that is based on a uniform distribution where the phase range is 05qKn. This is to determine the effect of phase synchronization error on the spectrum based detection method. For a given BER of IO4, simulation result shows that the performance downgrades by 1.5 dB compared to the coherent detection but hennery than no coherent detection by 3 dB. There is no significant difference in terms of the BER performance for the spectrum based detection whether a complex sinusoid or complex square wave is used.

[6]As concern with telecommunication engineering, we studied about digital modulation technique. Different type of modulation technique use transmitting and receiving massage signal at RF frequencies. All type of signal in air is analog in nature, so we have to analyses that signal. By using matlab tool, here we are implement the different type of modulation technique along with their mathematical representation. In this paper we are implementing different type of modulation technique such as massage signal which is binary in nature they lie on carrier frequency. Means that massage signal travels with carrier frequencies that is in analog mature. So, we have to analysis carrier frequency parameter like amplitude, phase, and carrier frequency varied according with massage signal or baseband signal. Simulation frame work operation act as like real world operation over time. That’s reason we implement simulation in matlab, to help as real world characteristics. If we change parameter of system we can observe different operating signal. Because, we can made these Simulink model in matlab .so, we can observed and calculate delay, power spectral density, noise. If suppose we implement spectrum analyzer with these a system, we can easily calculate all these things.

CHAPTER 3

MIMO SYSTEM ANALYSIS

3.1 MIMO SYSTEM

Multiple input-multiple outputs (MIMO) work as a multiple antenna system. The MIMO technology stands out to be excellent in utilizing multiple signals which are received from the wireless medium. This has effectively improvised wireless channel operation. As MIMO transmission employs numerous antennas at both ends of the communication link; it fallouts to be a tremendously spectrum-efficient technology. The factors which enhances the capability and performance of MIMO are- higher data rates, an increased number of users, greater spectral efficiency, enhanced reliability and many more. These factors not only improvise the performance level but also overcome many drawbacks of noise and propagation which other technology cannot. MIMO provides the gateway to a variety of new applications by multiplying spectral efficiency. It also lowers the cost of implementation to a much extent.

Basically, the links which affects the performance parameters and explicate the quality and expediency of any wireless linkage are range (or coverage), speed (or spectrum) and reliability (or security). Employing multiple waveforms transmission in parallel comprised of an innovative type of radio communication. The only way to recover all the three basic links of performance parameters of MIMO is to make use of multi-dimensional signals. Devoid of additional frequency spectrum, a multi antenna system which is widely known as MIMO accomplishes various features like wider coverage, increased reliability and elevated data rates. Multi antenna system along with multicarrier system in combination confers tremendous results.

In 1896, Guglielmo Marconi [15] was the first one who illustrated non-line-of-sight (NLOS) wireless communication system. Since then many technicians examined multipath signals as a

solemn hurdle in attaining greater and finer operations. Many researchers have been conducted to overcome such downsides as mentioned above. The very first paper brought up analyzing MIMO‟s capability was published in Global Communications Conference Proceedings in1996. There spurts up incessant expedition for escalating capability and enhanced quality in wireless mobile radio communication. There are such advantages which are imbibed by MIMO technology and it has proved it in several fields. Let's see some more aspects of MIMO System.

3.2 SPATIAL MULTIPLEXING

The well- publicized observable fact of mobile communication surroundings is multipath promulgation. Multipath propagation can be professed as intervention of noise signals or mortifying a receiver's capacity to recuperate the intellectual information or data. Increment of range/coverage and trustworthiness can be visualized in a positive way as MIMO extracts out gain of multipath propagation. And this task is consummated by sending and receiving several data signals in exactly same radio conduit and that too at the same time. It can be minimally impound it in a sole word as „Spatial Multiplexing". Spatial Multiplexing connotes communication of parallel information streams in space.

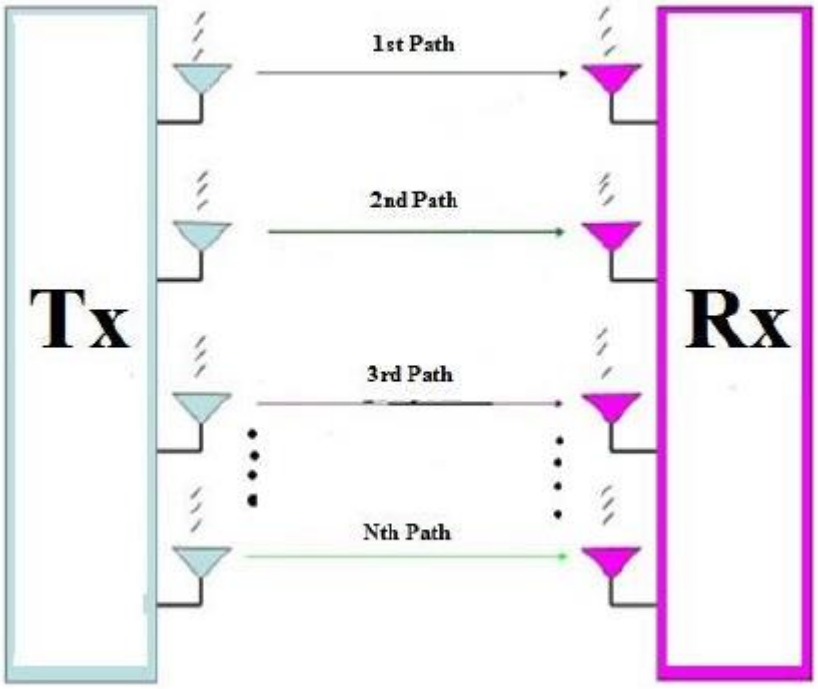

Figure 3.1:-Schematic Diagram of Spatial Multiplexing. [25]

This basic magic which lies in the an efficient antenna system incarcerate in the fact that without bringing up any change in the transmission ability; multiple transmitting antennas carries identical information and the receiving antennas also receives manifold signals of the unchanged information. Finally at the reception point it is to deem the strongest signal. This is widely call spatial diversity. Almost all the diversity techniques pursue similar conception as it is in smart antenna. Imbibing with various other additional capabilities MIMO stands out to be different from smart antenna systems because it is itself a proficient spatial diversity technique.

There are two or more than two transmitting antennas as well as two or more than two receiving antennas in the MIMO system. In a single channel, MIMO is capable of transmitting and receiving two or more radio signals and here every signal holds distinctive information. And the data rates delivered per channel in this case is also two or more times higher. This is widely named as „Spatial Multiplexing“. In a broad sense it can be said that MIMO utilize the most of it by spatial multiplexing and spatial diversity techniques as well.

3.3 SYSTEM BASED ON SPACE DIVERSITY

The signal can be transmitted through numerous different propagation pathways in space diversity. Wireless transmission caters us a technique where it can be easily attain the antenna diversity by making use of multiple transmitter antennas (which can also be called as transmit diversity) and multiple receiving antennas (which can also be called as diversity reception). Currently as far as diversity [16] is taken into account, there are four different types of systems which are categorized. Input and Output are referred to the numeral of antennas.

Following are four basic systems:

1. Single input-single output (SISO): No diversity
2. Multiple inputs-single output (MISO): Transmit diversity
3. Single input-multiple outputs (SIMO): Receive diversity
4. Multiple inputs-multiple outputs (MIMO): Transmit receive diversity

Let's begin studying them one by one. Basically, SISO System is very simple to operate on and compacts with communication flanked by a receiver and a transmitter. Here, probability of occurring of error is vitally spoilt by fading. It can be conceptually represent other diversity techniques like SIMO, MISO, and MIMO in this way as shown in the figure.

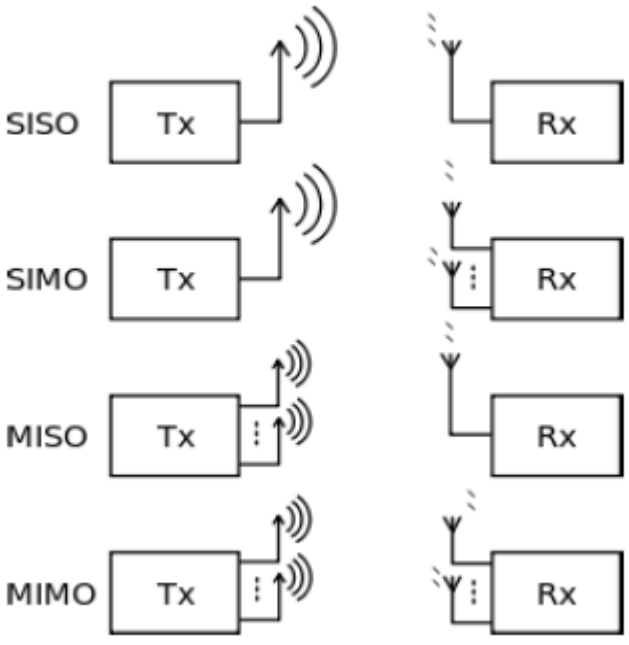

Figure 3.2:- Schematic Diagram of different types of system and spatial diversity

The conception of MRC can be applied in SIMO channel to take advantage of the receive diversity accessible. The probability of occurrence of error by the MRC is made to be much lowering analogous to the SISO channel.

The fading should be known to the receiver to perform MRC efficiently it can be said that the receiver should have direct access to the channel state information (CSI). Full CSI can be comprehended by having the comprehensive knowledge of the channel transfer function. But limited channel information is provided by the partial CSI. Usually it can be achieved by transporting some acknowledged signal through the channel. A momentous research work has been conceded out in the field of SIMO radio channel models. Here, there is a study of SISO System in a more large sense to have a better idea about the channel capacity.

3.4 COMPARISON OF CHANNEL CAPACITIES

3.4.1 SISO SYSTEM

According to Shannon, [17] it is known that the limit on the channel capacity is

$$C = B\log_2(1+SNR) \qquad (3.1)$$

This is what the SISO system is.

3.4.2 SIMO SYSTEM

There are M antennas at the receiver end being provided in the SIMO System. Subsequently, they can be consistently supplemented to generate M2 times raise in the signal power. Therefore, the increase in SNR is correspondent to

$$SNR \approx \frac{M^2.(SignalPower)}{M.Noise} = M.SNR \qquad (3.2)$$

Hence, the channel capability turns out to be

$$C = B\log_2(1 + M.SNR) \qquad (3.3)$$

3.4.3 MISO SYSTEM

There are N transmitting antennas for the MISO System. The entire transmitted power can be divided into N branches. Here, there is one receiving antenna and the total noise level is almost the same as it was there in the SISO case.

As a consequence, the whole increase in SNR is approximately

$$SNR \approx \frac{N^2.(SignalPower/N)}{Noise} = N.SNR \qquad (3.4)$$

Hence, the channel capacity in this case is:

$$C = B\log_2(1 + N.SNR) \qquad (3.5)$$

3.4.4 MIMO SYSTEM

Capacity of the MIMO channel is equivalent to:

$$C = B\log_2(1 + MN.SNR) \qquad (3.6)$$

The MIMO System can be viewed as a combination of MISO and SIMO systems. It can be easily conclude from the above analysis of equation that the capacity of the MIMO system is superior.

3.5 SYSTEM MODEL AND FUNCTIONING

For this proposed work the system model considered is shown below:

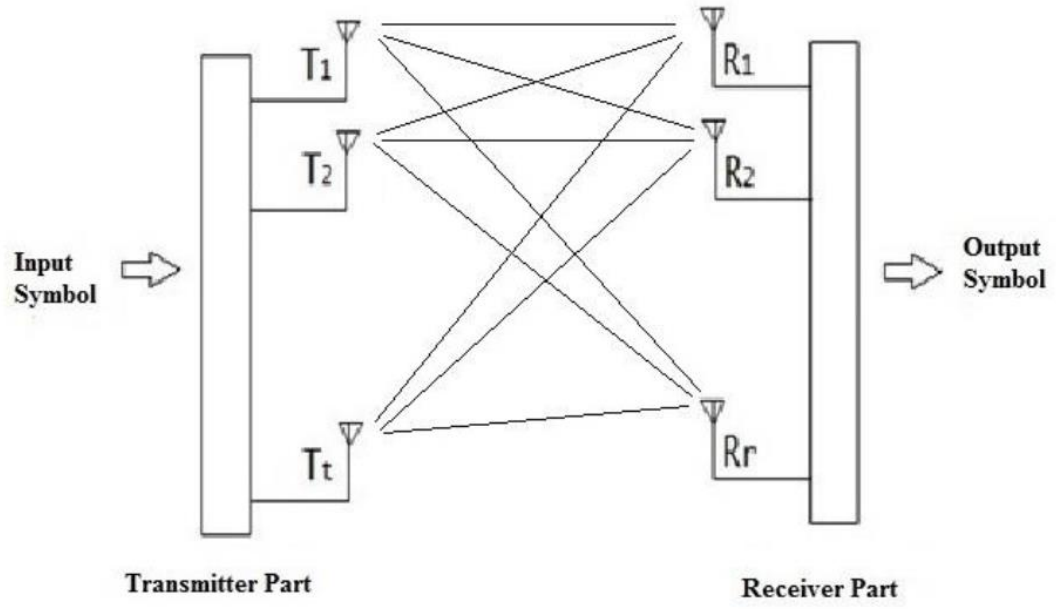

Figure 3.3: - Diagram of MIMO System Model.

Here, Tt transmit antennas and R_r receive antennas are in consideration. On the whole the channel can be embodied as a r*t complex matrix. H with the entries of $[H]_{r*t} \tilde{} h_{r*t}$ where h_{r*t} is the flat fading coefficient of the channel from the t^{th} transmit antenna to the r^{th} receive antenna. Now the MIMO system model can be shown as:

$$\begin{bmatrix} y_1 \\ y_2 \\ \cdot \\ \cdot \\ y_r \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & \cdot & \cdot & h_{1t} \\ h_{21} & h_{22} & . & . & h_{2t} \\ . & . & . & . & . \\ . & . & . & . & . \\ h_{r1} & h_{r2} & . & . & h_{rt} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ x_t \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ . \\ . \\ n_r \end{bmatrix}$$

The above System Model can be rewritten as:

$$\bar{y} = H\bar{x} + \bar{n} \qquad (3.7)$$

Where,

$\bar{y} = r$ dimensional receive antenna.

$H = r \times t$ dimensional channel matrix.

$h_{r\times t}$ = flat fading channel coefficients.

$\bar{x} = t$ dimensional transmit antenna.

$\bar{n} = r$ dimensional noise.

A successful methodology for improvisation of trusted communication over a wireless structure is to use too many antennas which should have the following properties:

3.5.1 ARRAY GAIN

It is defined as the average increase in the proportion of noise to signal at receiver obtained by coherent combining of multiple antenna signals at the receiver or at the transmitter side or at both sides. As the number of receive antenna increases, signal power increases i.e., the average increase in signal power is proportional to the number of receive antennas [18]. In case of multiple antennas at the transmitter, array gain requires channel knowledge at the transmitter.

3.5.2 INTERFERENCE REDUCTION

Co channel interference deteriorates performance of the system and bestow to the aggregated system's noise. System capacity can be improved by using multiple antennas that suppress interfering signals. Interference reduction requires knowledge of the channel of the desired signal, but exact knowledge of channel is not necessary [18].

3.5.3DIVERSITY GAIN

An effective method to contend with fading is diversity. Methodologies of diversification are categorized into time, frequency & diversification of space. Space or antenna diversity can be classified into two categories: receive diversity and diversity of transmit [19], which depends upon whether too many antennas are required for transmission or reception.

3.5.4RECEIVE DIVERSITY

Receive diversity is characterized by the number of independent fading signals and it is at most equal to the number of receive antennas. Its use can be made in channels with several antennas at the end of the receiver. The signals to be received are presumed to fade individually and are joined at the receiver so that the signals which are presented as outcome visualize significantly minimized fading.

3.5.5 TRANSMIT DIVERSITY

Transmit diversity is applicable to channels with multiple transmit antennas and it is at most equal to the number of the transmit antennas, especially if the transmit antennas are placed sufficiently apart from each other. Information is dealt at the transmitter & then distributed across the several antennas.

CHAPTER 4

PROBLEM STATEMENT

Multiple input-multiple outputs (MIMO) work as a multiple antenna system. The MIMO technology stands out to be excellent in utilizing multiple signals which are received from the wireless medium. This has effectively improvised wireless channel operation. As MIMO transmission employs numerous antennas at both ends of the communication link; it fallouts to be a tremendously spectrum-efficient technology.

In 1896, Guglielmo Marconi [1] was the first one who illustrated non-line-of-sight (NLOS) wireless communication system. Since then many technicians examined multipath signals [2-3] as a solemn hurdle in attaining greater and finer operations. Many researchers have been

conducted to overcome such downsides as mentioned above. The very first paper brought up analyzing MIMO's capability was published in Global Communications Conference Proceedings in1996. There spurts up incessant expedition for escalating capability and enhanced quality in wireless mobile radio communication. The consistent transmission entails ciphers to be successfully detected at the receiving edge. For MIMO System, the best soft decoder used for the minimization of the BER is usually the maximum-likelihood (ML) detector [5-6]. On the contrary, the foremost shortcoming spurts up in the detection process is that it sometimes turn out to be extremely complicated because of its complex design. This leads to an enhance increment with escalate number of antennas which are relaying information at the transmitter & also directly equivalent to its arrangement. In [7] and [8], the detection scheme has been upgraded through some estimation of data proximity. In [9], many minimized complicacy realizations of the schema of detector are followed back so that by taking the help of only one matrix inverse, we can able to estimate each transmitted symbols. Therefore, this detection scheme can act as a propitious candidate in practical case.

4.1 MIMO MODEL ANALYSIS

The MIMO model considered for this proposed work is shown in Figure.. Here, we consider T_t no. of transmit antennas and R_r no of receive antennas. The overall channel can be represented as a r * t complex matrix H with the entries of H_{r*t} $\tilde{h}_{r*t}$ where is the flat fading Rayleigh coefficient of the channel from the t th transmit antenna to the r th receive antenna.

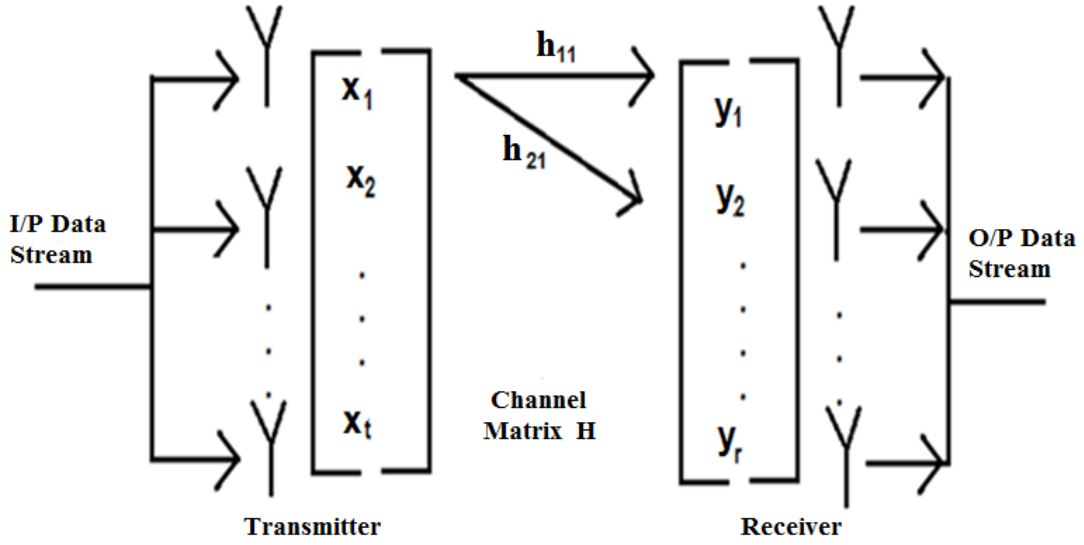

Figure 4.1:- Block diagram of MIMO system

4.2 MAXIMUM LIKELIHOOD (ML)

Maximum Detection (ML) symbol detection method is one of the optimum methods of detecting the transmitted symbols at the receiving part, which are being transmitted from the transmitting part. This detection scheme is non linear in nature. According to this principle, the estimated symbol can be estimated as:

$$X = \arg\min \left| x - H_s^2 \right| \qquad (1)$$

Where, $H_s$is the estimated symbol vector from H .

4.3 ZERO FORCING (ZF)

Zero Forcing (ZF) is the one of the widely used detection method having low computational complexity. The Zero Forcing detection scheme is linear in nature but it suffers from sudden noise enhancement. At some high value of SNR, it gives optimum result. Now, the estimated result is given by.

$$\hat{X} = \left(H^{\#} H\right)^{-1} H^{\#} \bar{y} \qquad (2)$$

Where, $H^{\#}$ represents the pseudo-inverse of H .

4.4 MINIMUM MEAN SQUARE ERRORS (MMSE)

The MMSE detector holds back both interference as well as noise components, but in comparison with ZF detector, it only removes the interference or the noise. From this we can come to a conclusion that the mean square error (MSE) is minimized. To overcome the drawback of sudden noise enhancement of ZF, the concept of MMSE is introduced for detection. So, we can say that, MMSE is pretentious to ZF in the presence of noise and interference. Hence, the Linear Minimum Mean Square Estimator for the MIMO System is.

$$\hat{X} = P_d H^{\#} (HH^{\#} + \sigma_n^2)^{-1} \bar{y}. \qquad (3)$$

P_d = Power of each diagonal element.

σ_n^2 = Power of noise component

4.5 QR DECOMPOSITION

The QR Decomposition is an effective technique of solving matrix inversion problem. Hence, for a given matrix, we can find out its QR Decomposition as

$$A = QR \quad (4)$$

Where, R is the upper triangular matrix and Q is the orthogonal matrix, satisfying $Q^T.Q = I$

Quadrature amplitude modulation is a plot of modulation in which two carriers which are sinusoidal, one to be exact 90 degrees out of phase in regard to each other, are required to relay data over a channel. Because the orthogonal bear occupancy the frequency of same band of range but possess a difference of 90 degree shift of phase, every single one of them modulated

distinctively, relayed over the similar range of band of frequency, & distinct by demodulation at the end of receiver. For a provided bandwidth, QAM permits transmission of data at around two times the rate of modulation of standard pulse amplitude by not co tempting the rate of error of bit. QAM along with its substitutes are required in communication systems like mobile radio & satellite.

QAM is sort of signal in which outcome is comprised of both amplitude & variations of phase. Formats of QAM which are digital are referred as Quantized QAM and they are widely needed for data transmission often within systems of communication like radio. Communications systems like radio which varies from cellular technology through systems which are wireless consisting WiMAX, and Wi-Fi 802.11 use variegated types of QAM, & the requirement of QAM will only raise up within the field of communications of radio. 16- QAM uses 4 levels in the I direction and 4 levels in the Q direction for a total of 16 symbols. 32-QAM uses a total of 32 symbols in the constellation.

BER performance comparison for a MIMO system with fixed transmitting and receiving antenna i.e. Tx=2 and Rx=2 for ZF, MMSE, QR, MMSE-SIC, ZF-SIC and ML detection scheme for Rayleigh channel. From the curves shown, it can be concluded that the value of BER for ML detection is low compared to the other detection techniques.

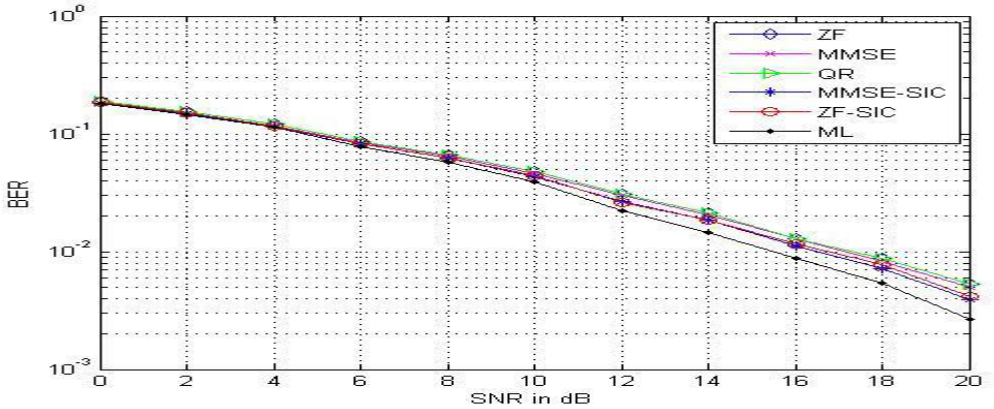

Fig.4.2: BER analysis for Tx=2, Rx=2 for 64-QAM

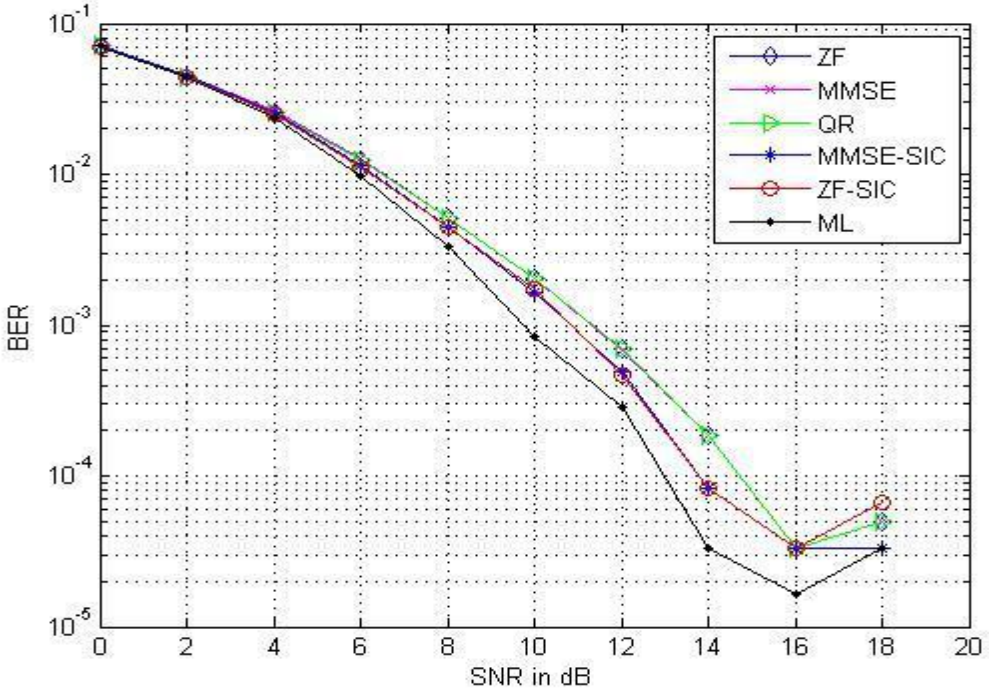

Figure. 4.3: BER analysis for Tx=2, Rx=4 for 64-QAM

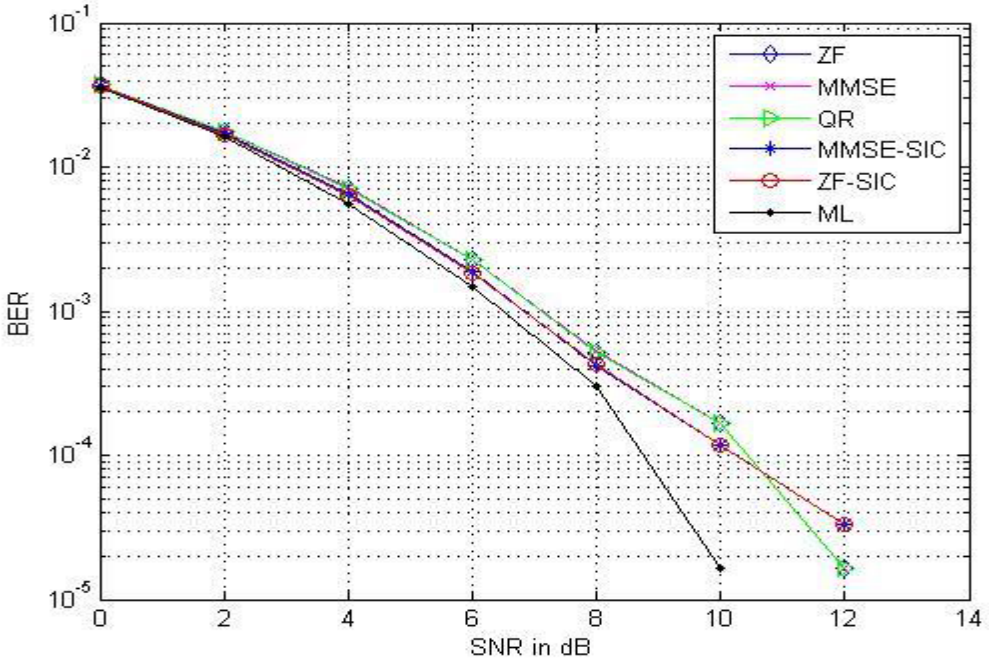

Figure.4. 4: BER analysis for Tx=2, Rx=6 for 64-QAM

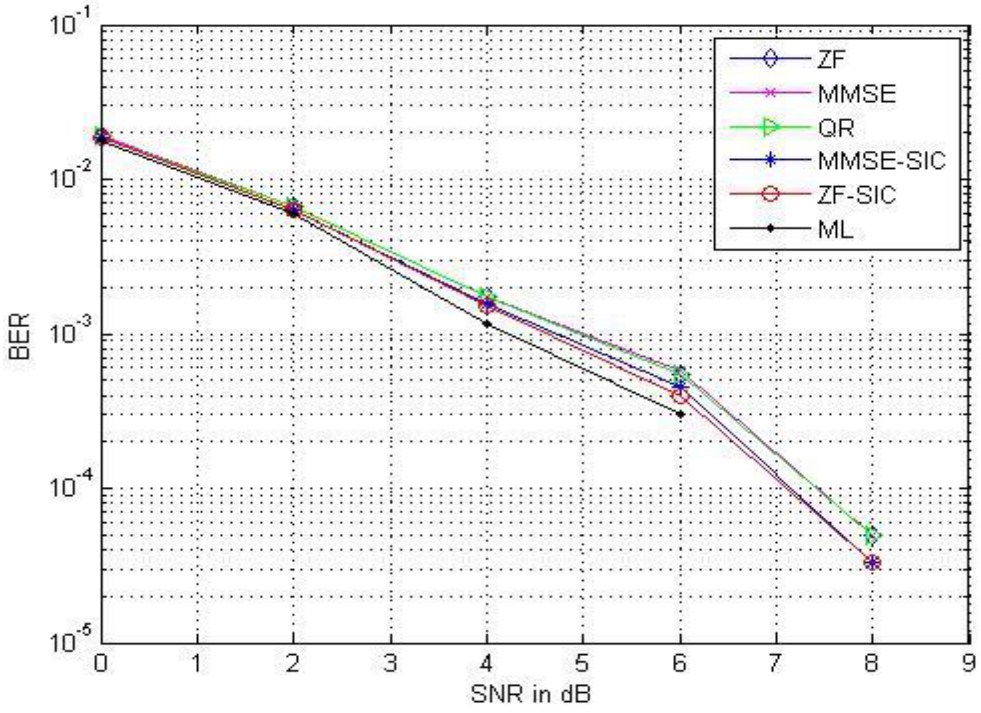

Figure. 4.5: BER analysis for Tx=2, Rx=8 for 64-QAM

CHAPTER 5

PROPOSED METHODOLOGY

5.1 QUARDERATURE MODULATION TECHNIQUE

Quadrature amplitude modulation (QAM) is both an analog and a digital modulation scheme. It shuttles two missive of signals which are analog, or two digital bit streams, by changing (modulating) the amplitudes of two carrier waves, using the amplitude-shift keying (ASK) digital modulation scheme or amplitude modulation (AM) analog modulation scheme. The two waves referred as carrier waves, usually sinusoids, are out of phase with each other by 90° and are thus called quadrature carriers or integrants of quadrature— thus the definition of stratagem. The summing up of waves which are modulated is done, and the out produced waveform is an amalgam of both phase-shift keying (PSK) and amplitude-shift keying (ASK), or (in scenario of analog) of modulation of phase & modulation of amplitude. In the scenario of digital QAM, a defined quant of minimum two phases & amplitude is needed. The postulates of QAM are often needed to structurize PSK modulators, but since the amplitude of signal of modulated carrier wave is quite stable but still they are not taken into account as QAM. Substantially use of QAM is made as a schema of modulation for digital telecommunication systems. Arbitrarily high effectiveness can be attained with QAM by defining a matching size of constellation, paltered only by the level of noise and communication passage's linearity.

Like all modulation schemes, QAM conveys data by changing some slants of a signal of carrier wave which is generally a sinusoid as per the response of the signal of data. In the scenario of QAM, the two waves possessing amplitude, 90° out-of-phase in relation to each other are modified to constitute the signal of data. Carriers that are being modulated by amplitude in two quadrature can be seen neutrally as both amplitude & phase modulating a sole carrier.

Modulation of phase which is analog PM & phase-shift keying that is digital PSK can be considered as a exceptional scenario of QAM, where the magnitude of the signal which is being modulated is a stable, with only the phase that is fluctuating. This can also be broadening to frequency modulation & frequency-shift keying (FSK), for these can be taken in account as an exceptional schema of phase modulation.

5.2 ML (MAXIMUM LIKELY HOOD

Maximum Detection symbol detection method is one of the optimum methods of detecting the transmitted symbols at the receiving part, which are being transmitted from the transmitting part. This detection scheme is non linear in nature.

5.3 QR DECOMPOSITION

The QR Decomposition is an effective technique of solving matrix inversion problem. Hence, for a given matrix, we can find out its QR Decomposition as

$$A= QR$$

Where R is the upper triangular matrix and Q is the orthogonal matrix

5.4 MINIMUM MEAN SQUARE ERROR-SUCCESSIVE INTERFERENCE CANCELLATION

The effects of spreading steadily in systems of OFDM/CDMA are the blending at the reception of signal to proportion of noise among the sub-bands which hamper the fair performance of algorithms of successively decoding.

5.4.1 SUCCESSIVE INTERFERENCE CANCELLATION

It is an ability of physical layer by which permission a receiver decode the packets that reach there eventually, SIC is the potential of a receiver to accept more than two signals simultaneouly.SIC can be made happen as the receiver might decode the stronger signal, subtract it from the combined signal, and extract the weaker one from the residue.

CHAPTER 6

RESULTS

6.1 FOR QAM 16 BITS

As the figure 6.1 is showing the comparison among all the used techniques . These techniques are ZF, MMSE , MMSE-SIC , ZF-SIC , ML. According to the graph 6.1 we are taking 4 transmitter and 6 receiver by use 16 bit QAM technique .

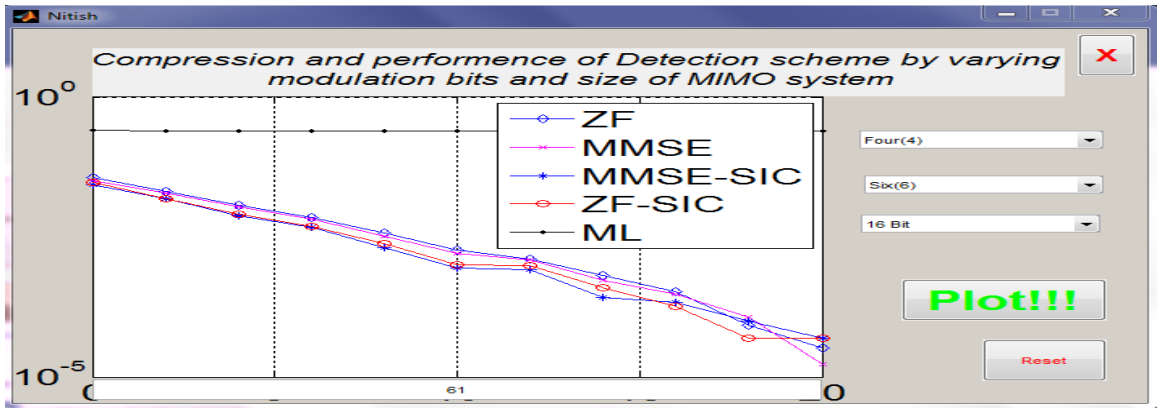

Figure 6.1:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.2 the graph is showing the results of the 16 bit QAM technique . In which 6 transmitter with 2 receiver are using .

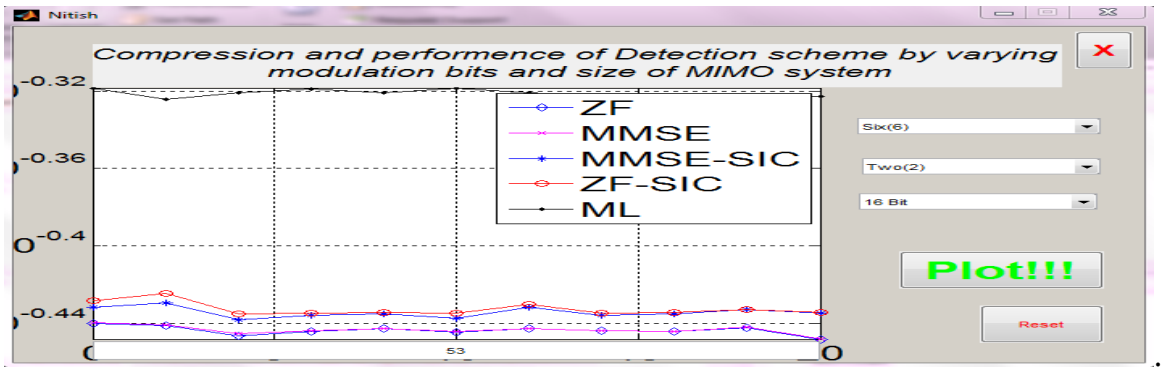

Figure 6.2:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

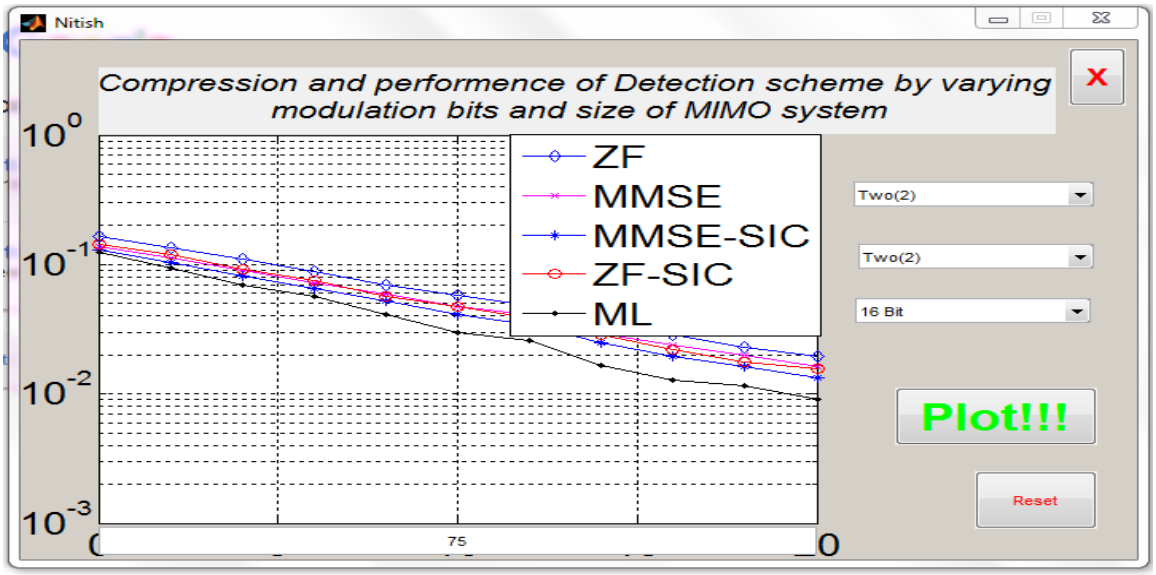

Figure 6.3:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.3 , 2 transmitter with 2 receiver are using . We are using 16 bit QAM technique for show the comparison graphs .

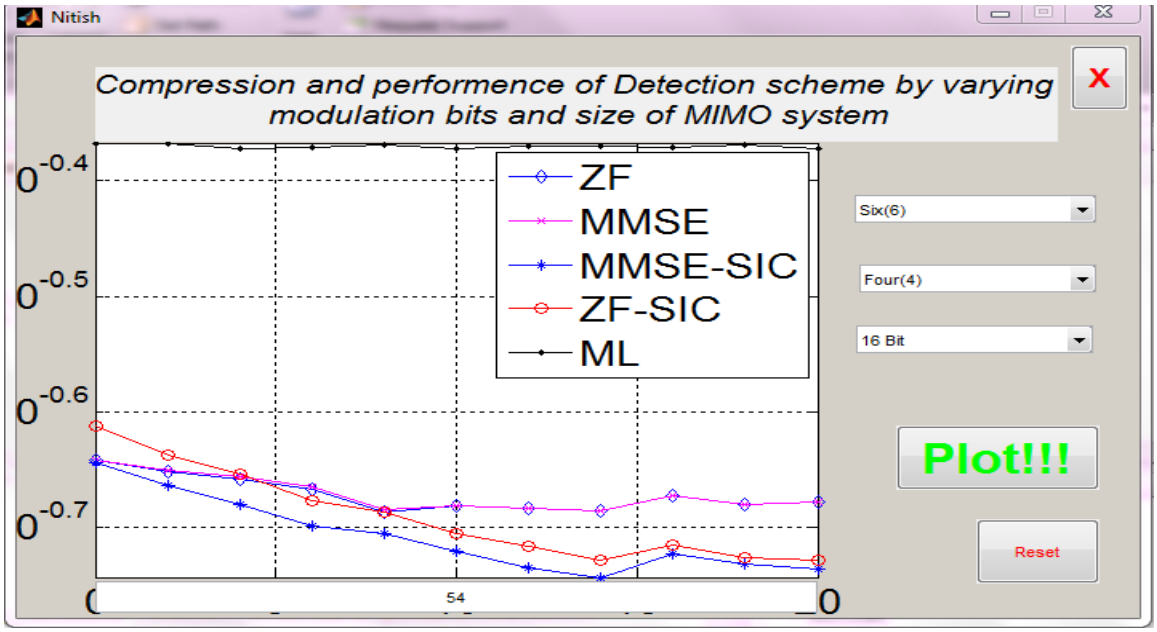

Figure 6.4:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.4 the graphs are showing the comparison among all the technique for 6 transmitter and 4 receiver . The modulation technique is using 16 bit QAM . The graph is showing that best technique among all the techniques is MMSE-SIC .

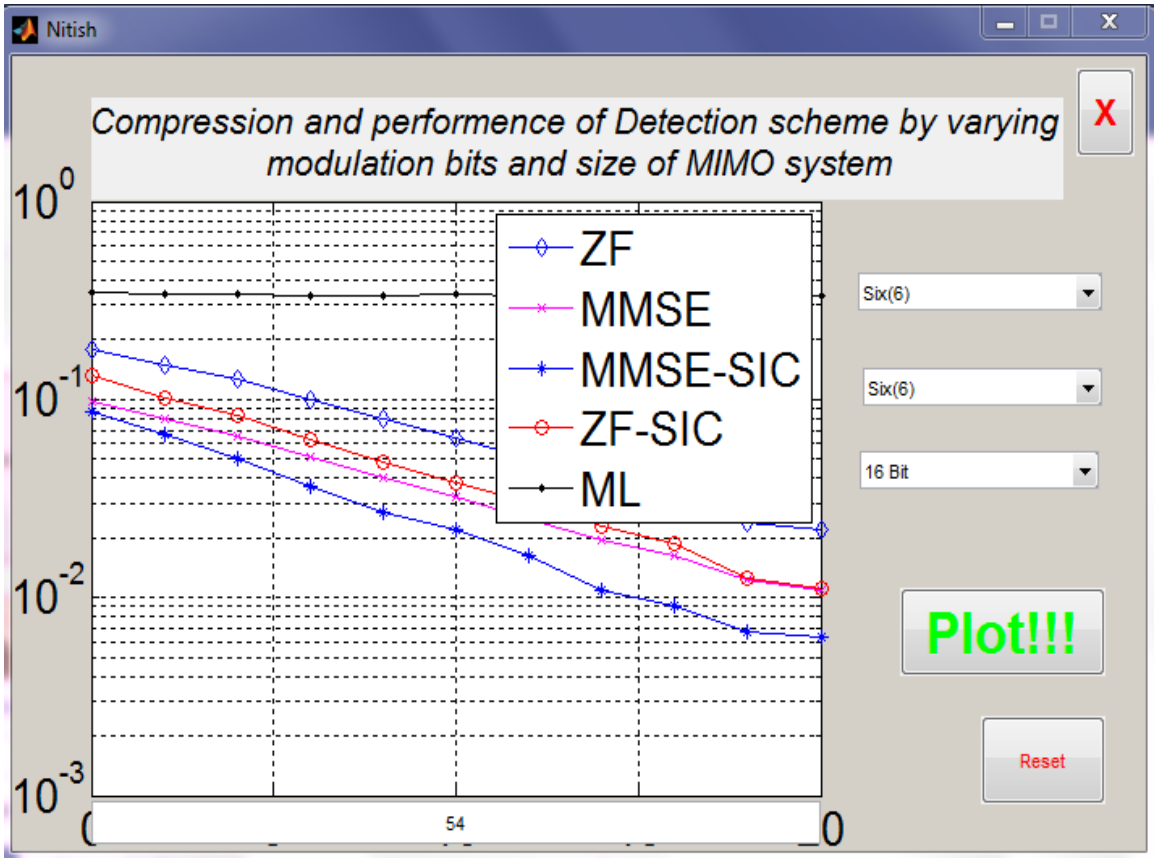

Figure 6.5:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to the Figure 6.5 the graphs is design in between ZF, MMSE , MMSE-SIC , ZF-SIC , ML . The results are showing for the 6 transmitter and 6 receiver . 16 bit QAM technique is using for improve the results . Among all the techniques the MMSE - SIC is the best technique for transmit the complete data from transmitter to receiver .

According to figure 6.6 , using 2 transmitter and 4 receiver . 16 bit QAM is using for improve the performance of the system .In this 2 transmitter are using with 4 receiver . MMSE-SIC is the best technique for transmit the data without any loss .

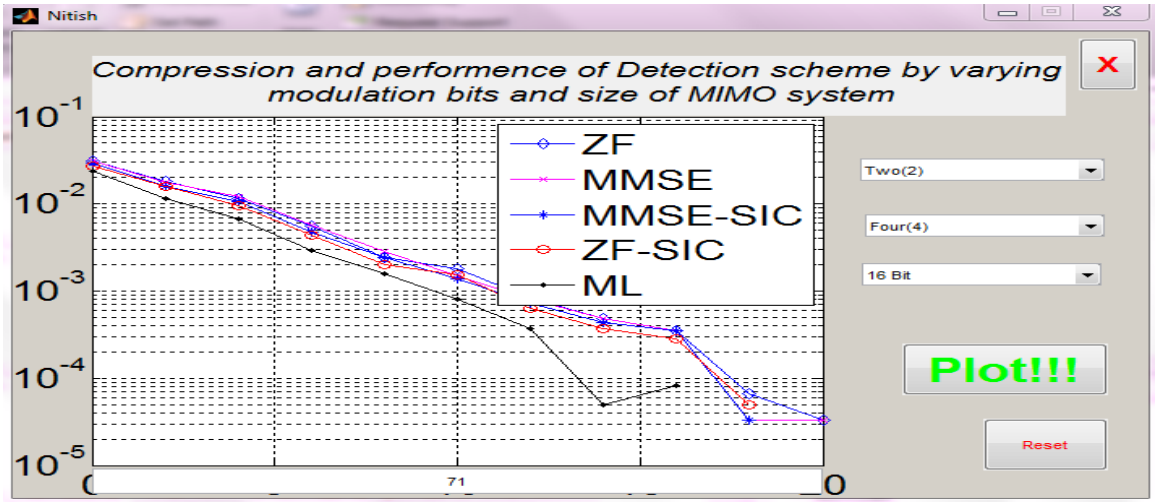

Figure 6.6:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.7 , 2 transmitter and 6 receiver are using . The results are improving by 16 bit QAM technique . According to the graphs ML technique is better for send the data from transmitter to receiver .

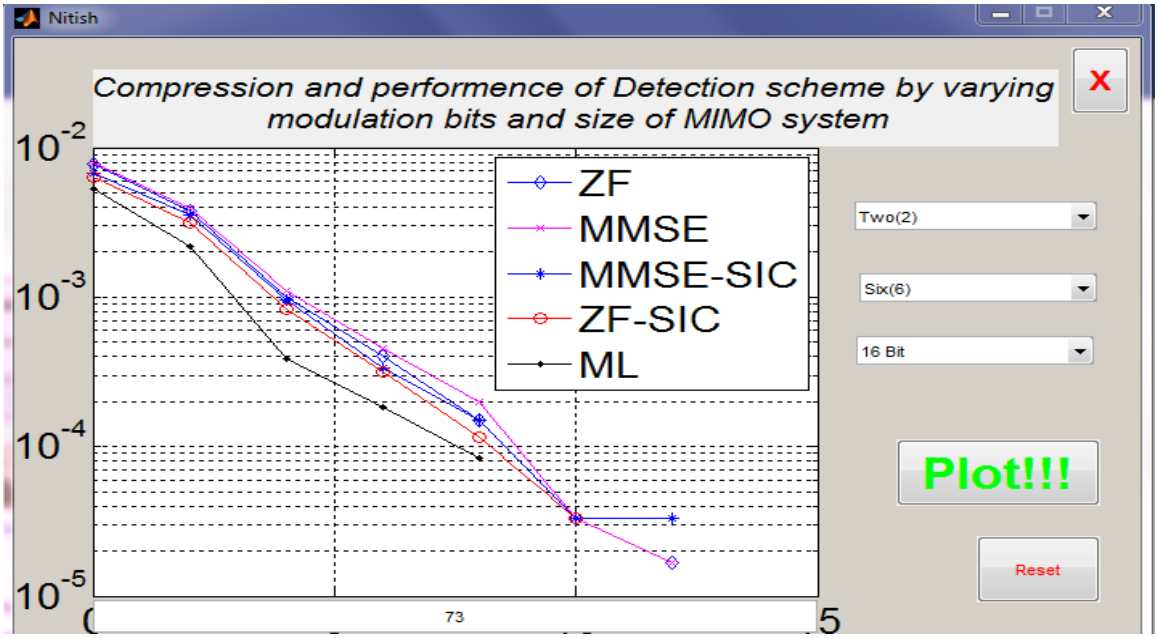

Figure 6.7:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

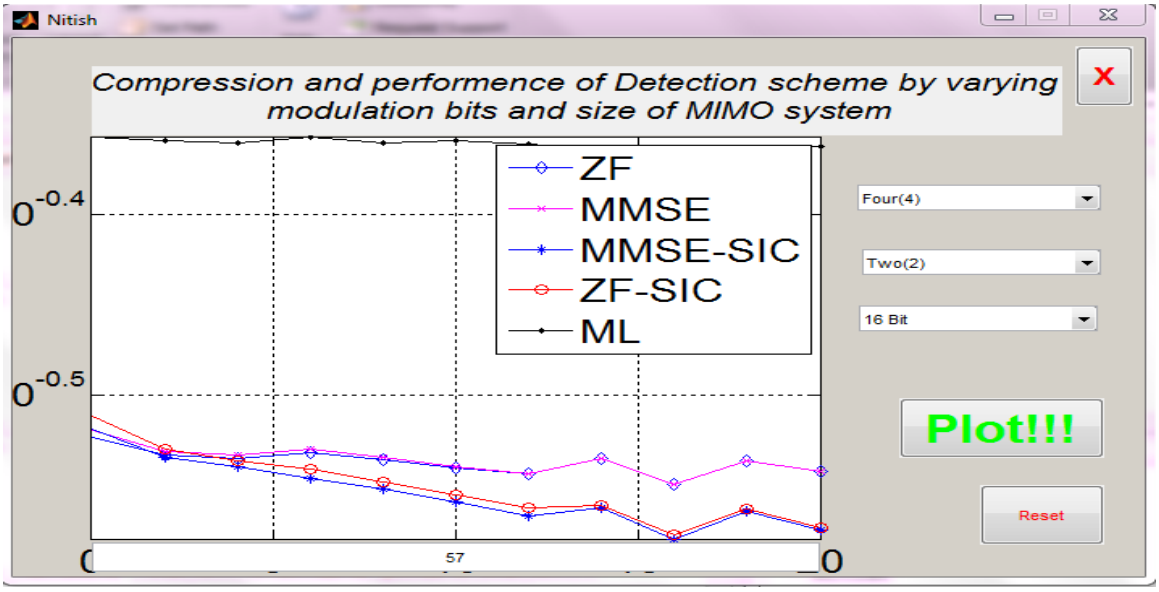

Figure 6.8:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Figure 6.9 is showing the results of the 4 transmitter and 4 receiver while the technique is using 16 bit QAM . The results of the techniques are showing that MMSE - SIC is a best technique for send and receive the data .

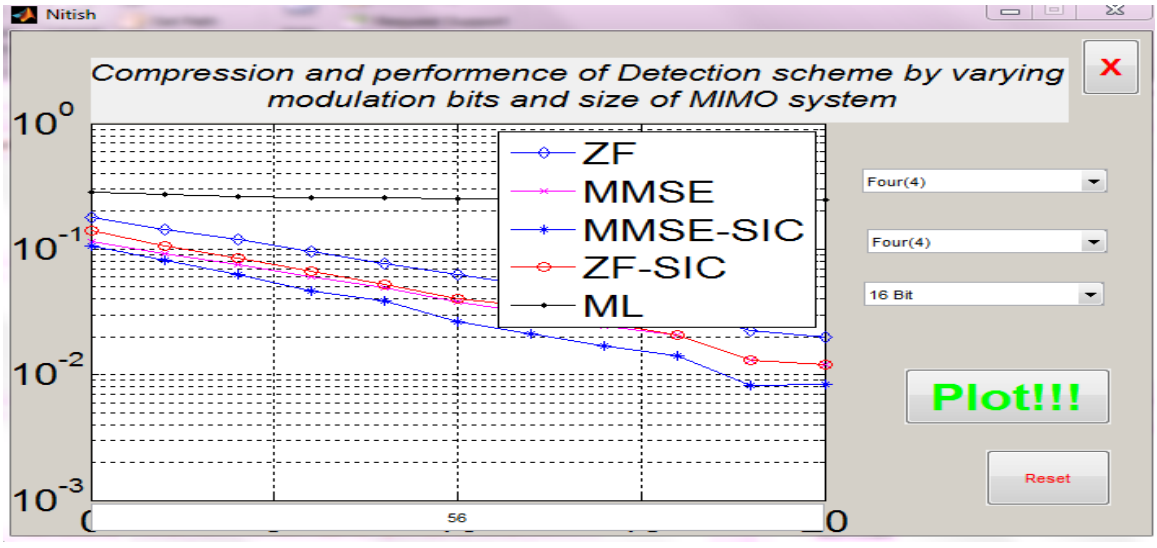

Figure 6.9:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Sr.	Tx.	Rx.	Time	Best Technique
1	2	2	115	ML
2	4	2	115	MMSE-SIC
3	6	2	86	ZF
4	2	4	112	ML
5	4	4	113	MMSE-SIC
6	6	4	86	MMSE-SIC
7	2	6	113	ML
8	4	6	93	MMSE-SIC
9	6	6	97	MMSE-SIC

Table 6.1:- 16 bit QAM

6.2 32 BIT QAM

According to Figure 6.10 the system is working for the 2 transmitter and 2 receiver for 32 bit QAM technique . The given graph is showing that the results are improving by ML technique that means system is showing that among all the technique ML technique is best .

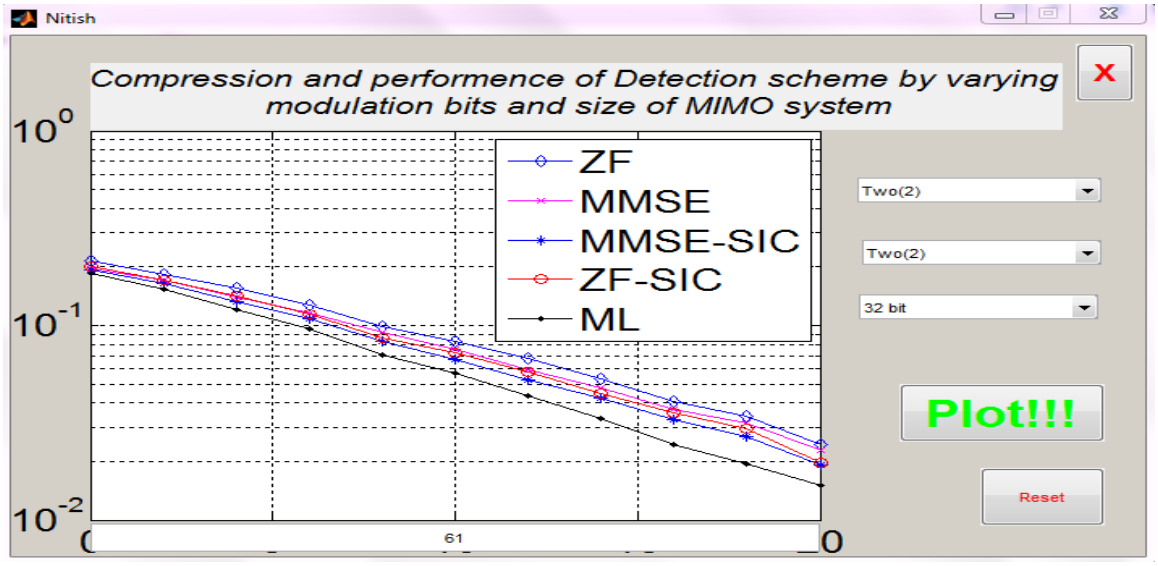

Figure 6.10:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.10 the system is showing the results for 2 transmitter and 2 receiver with 32 bit QAM. Among all the technique system is showing best results for ML technique .

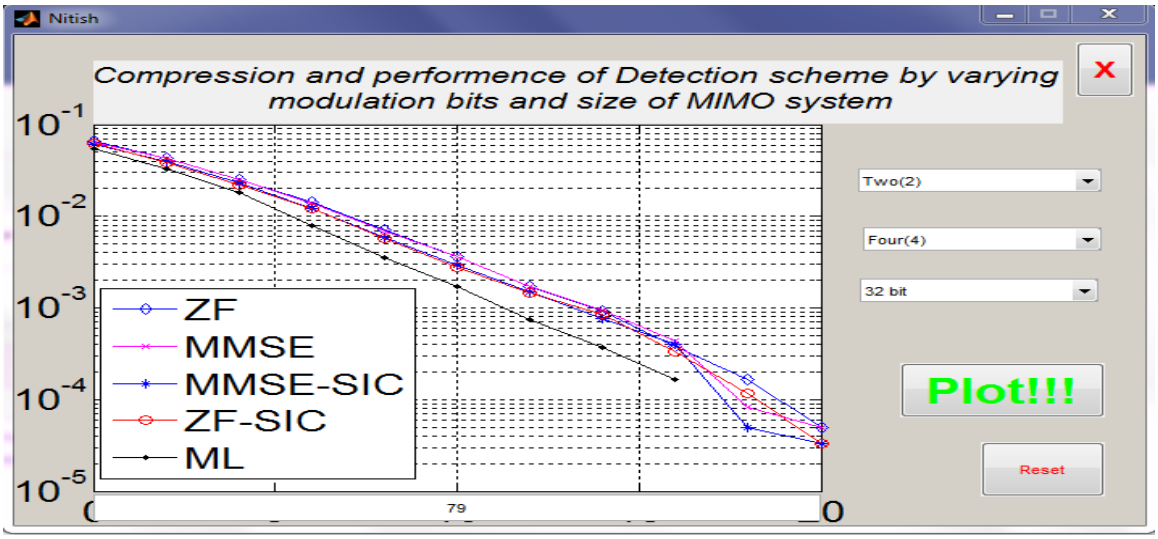

Figure 6.11:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Figure 6.12 is showing the results for 2 transmitter and 6 receiver.32 bit QAM technique is using for improve the performance. for all the techniques ML is the best for the 32 bit QAM data transmission and receiving .

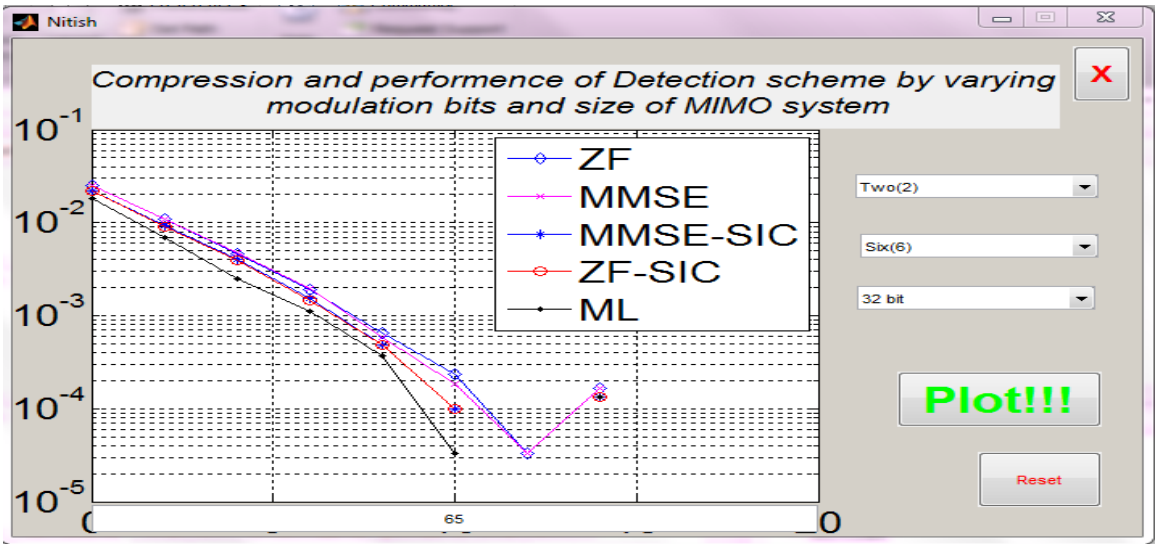

Figure 6.12:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Figure 6.13 is showing the results of the 4 transmission and 2 receiver . 32 bit QAM technique is using . MMSE-SIC is best technique among all the technique .

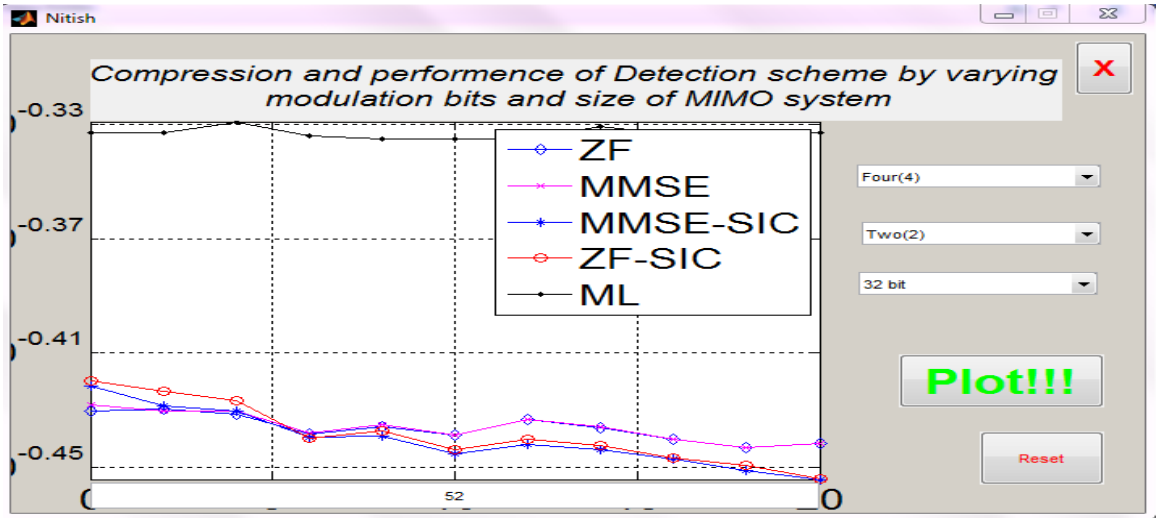

Figure 6.13:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Figure 6.14 is showing the results of the 4 transmitter and 4 receiver while the technique is using 32 bit QAM . The results of the techniques are showing that MMSE - SIC is a best technique for send and receive the data .

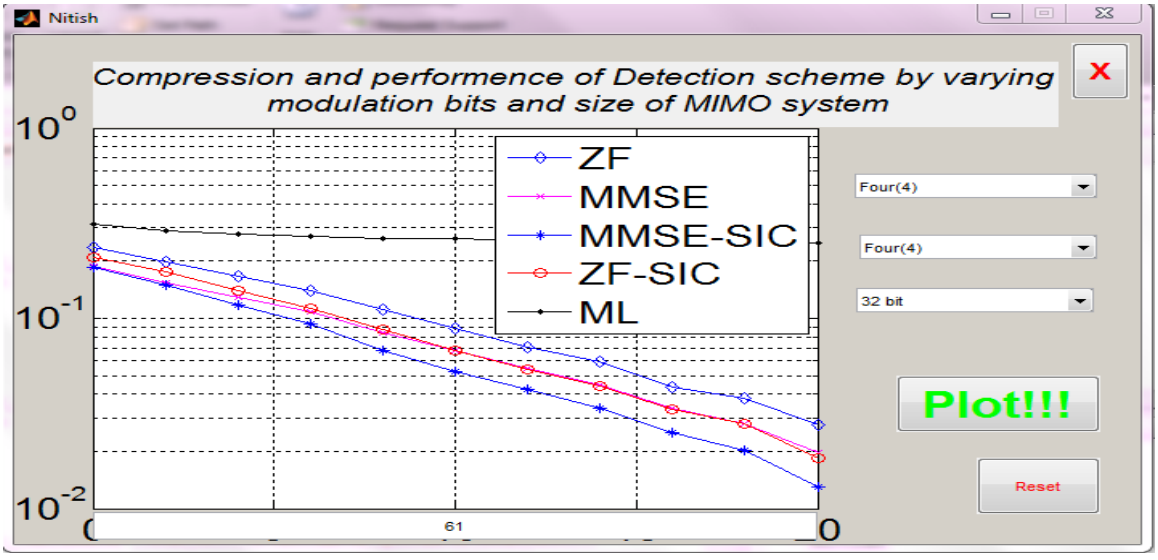

Figure 6.14:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.15 is showing the comparison among all the used techniques . These techniques are ZF, MMSE , MMSE-SIC , ZF-SIC , ML. According to the graph 6.15 we are taking 4 transmitter and 6 receiver by use 32 bit QAM technique .

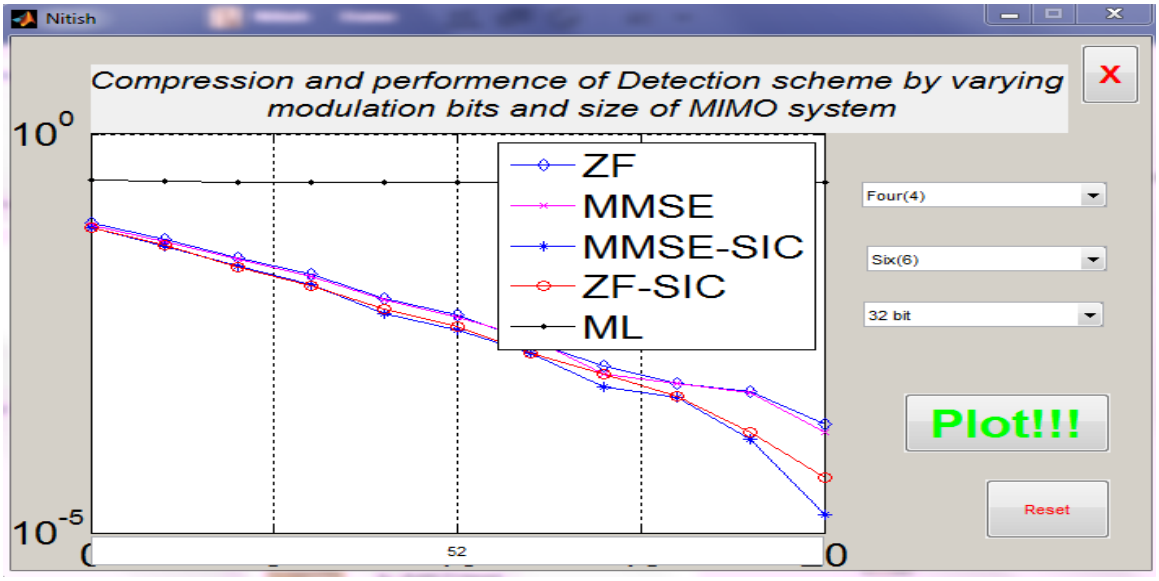

Figure 6.15:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.16 the graph is showing the results of the 32 bit QAM technique . In which 6 transmitter with 2 receiver are using .

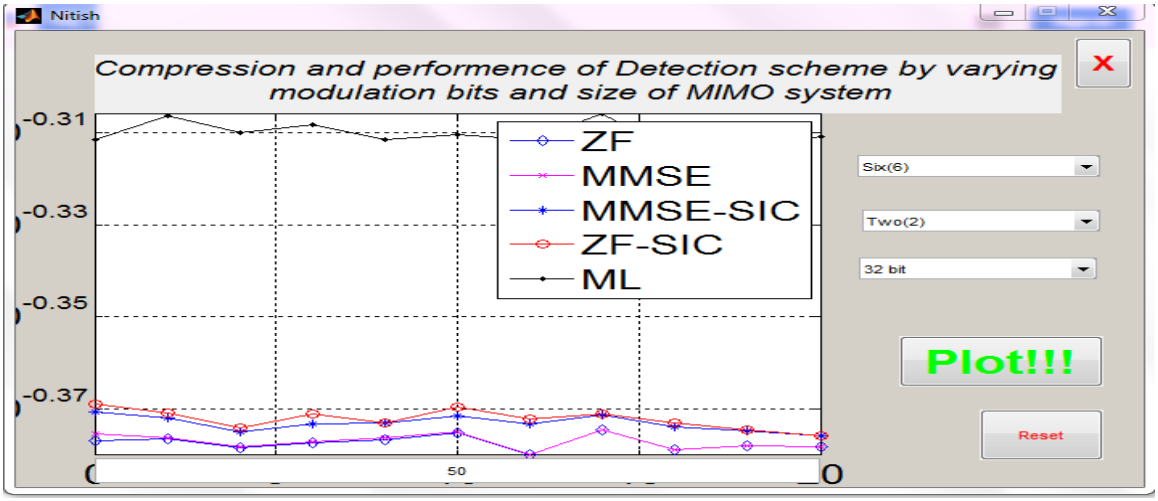

Figure 6.16:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

According to figure 6.17 , 6 transmitter with 4 receiver are using . We are using 32 bit QAM technique for show the comparison graphs .

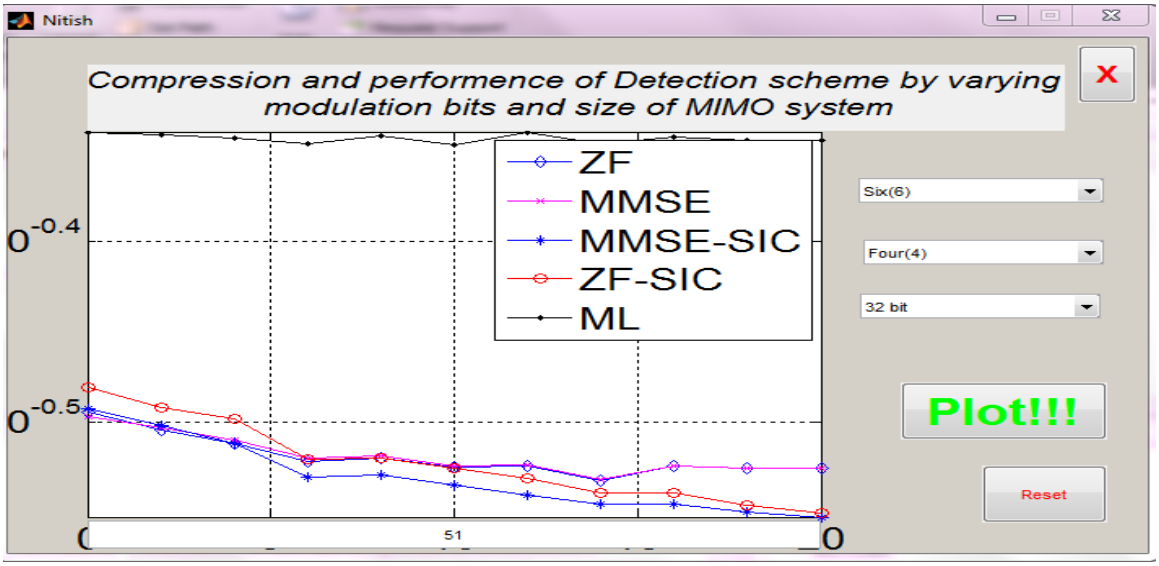

Figure 6.17:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.18 is showing the comparison among all the used techniques . These techniques are ZF, MMSE , MMSE-SIC , ZF-SIC , ML. According to the graph 6.18 we are taking 6 transmitter and 6 receiver by use 32 bit QAM technique .Among all the technique MMSE - SIC is giving the best results .

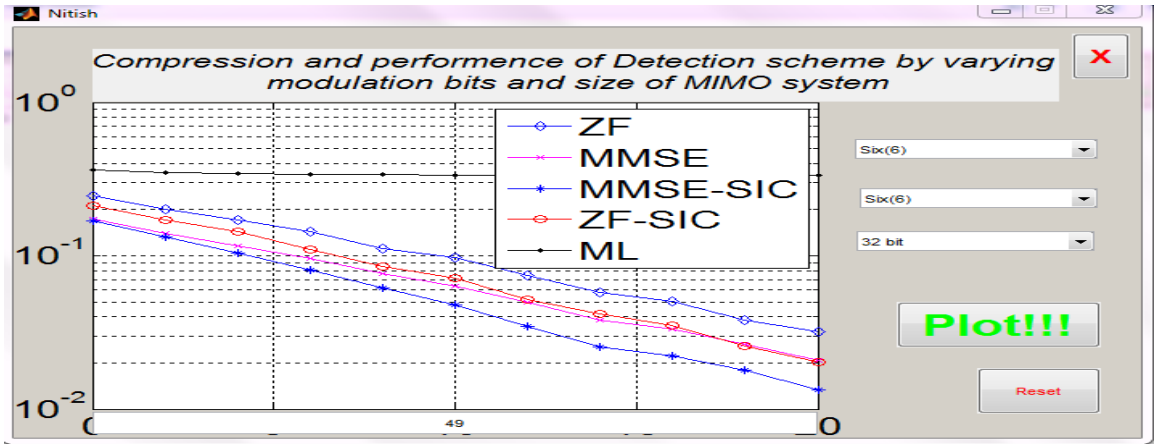

Figure 6.18:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Sr.	Tx.	Rx.	Time	Best Technique
1	2	2	94	ML
2	4	2	85	MMSE-SIC
3	6	2	77	MMSE
4	2	4	95	ML
5	4	4	76	MMSE-SIC
6	6	4	77	MMSE-SIC
7	2	6	95	ML
8	4	6	79	MMSE-SIC
9	6	6	76	MMSE-SIC

Table 6.2:- 32 bit QAM

6.3 64 BIT QAM

As the figure 6.19 is showing the comparison among all the used techniques .We are taking 2 transmitter and 2 receiver by use 64 bit QAM technique .Among all the technique ML is giving the best results .

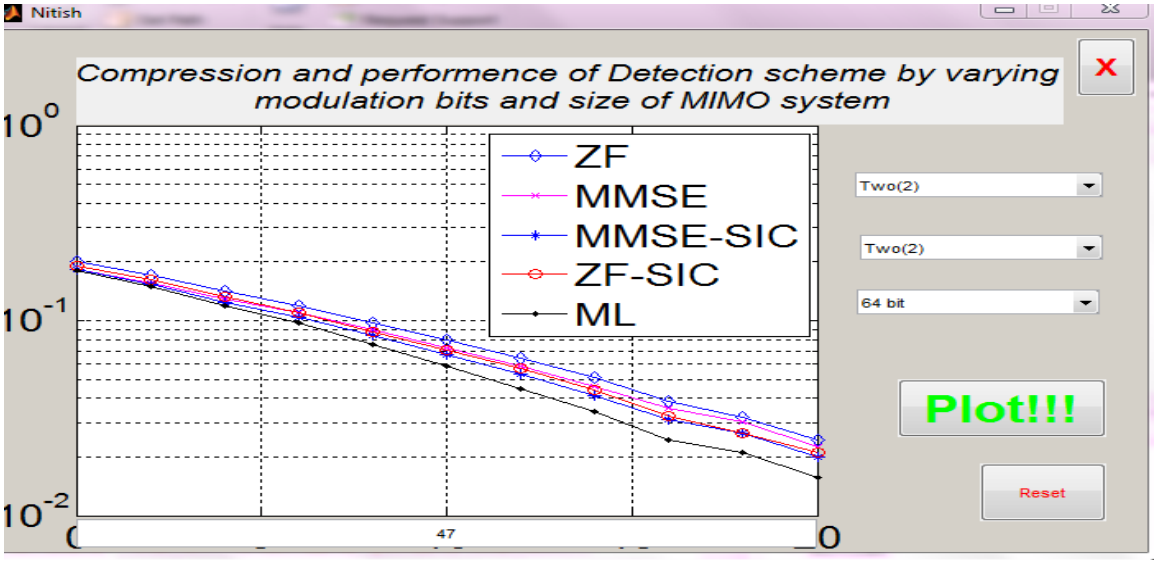

Figure 6.19:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.20 is showing the comparison among all the used techniques .We are taking 2 transmitter and 4 receiver by use 64 bit QAM technique .Among all the technique ML is giving the best results .

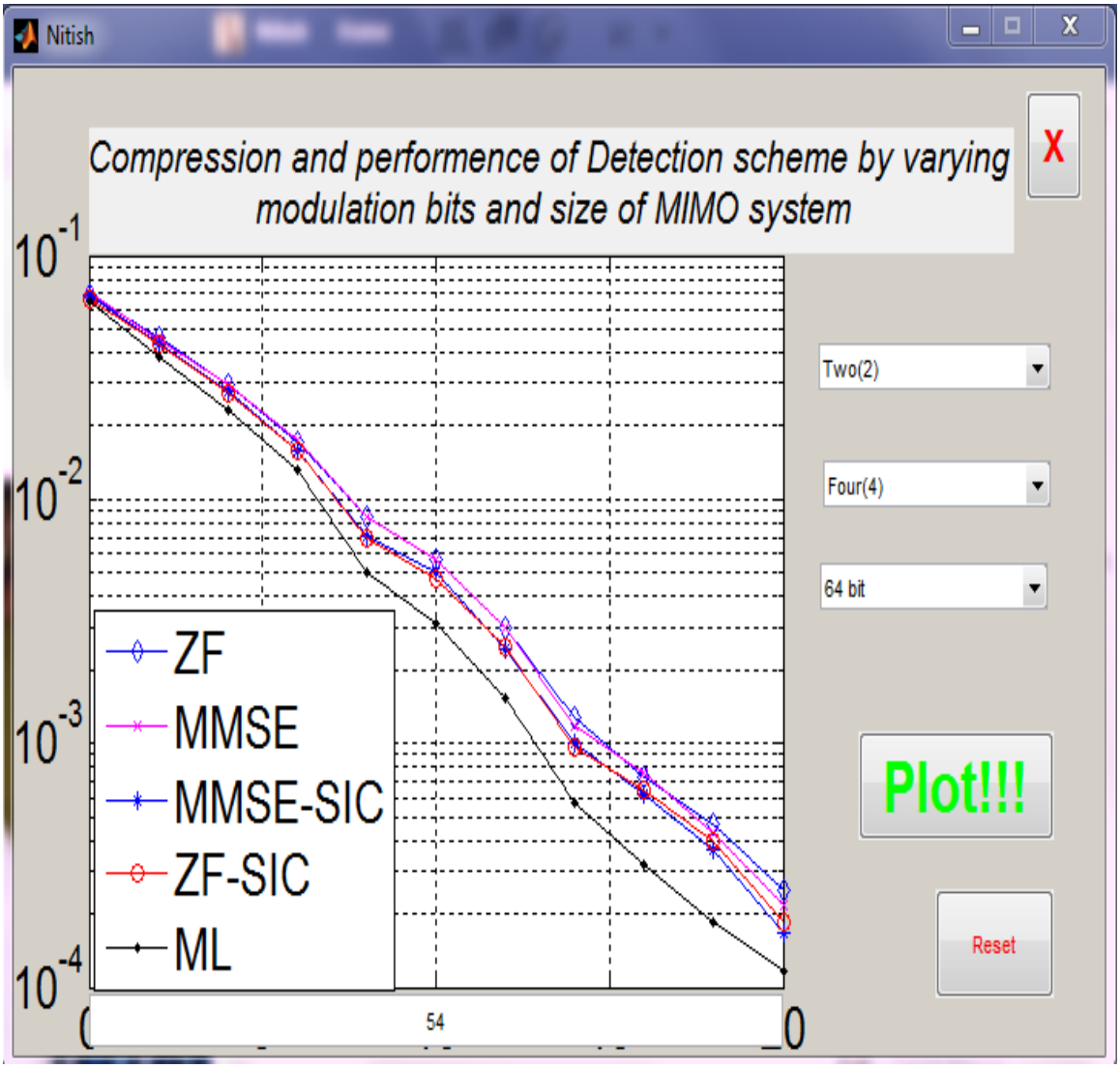

Figure 6.20:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.21 is showing the comparison among all the used techniques .We are taking 2 transmitter and 6 receiver by use 64 bit QAM technique .

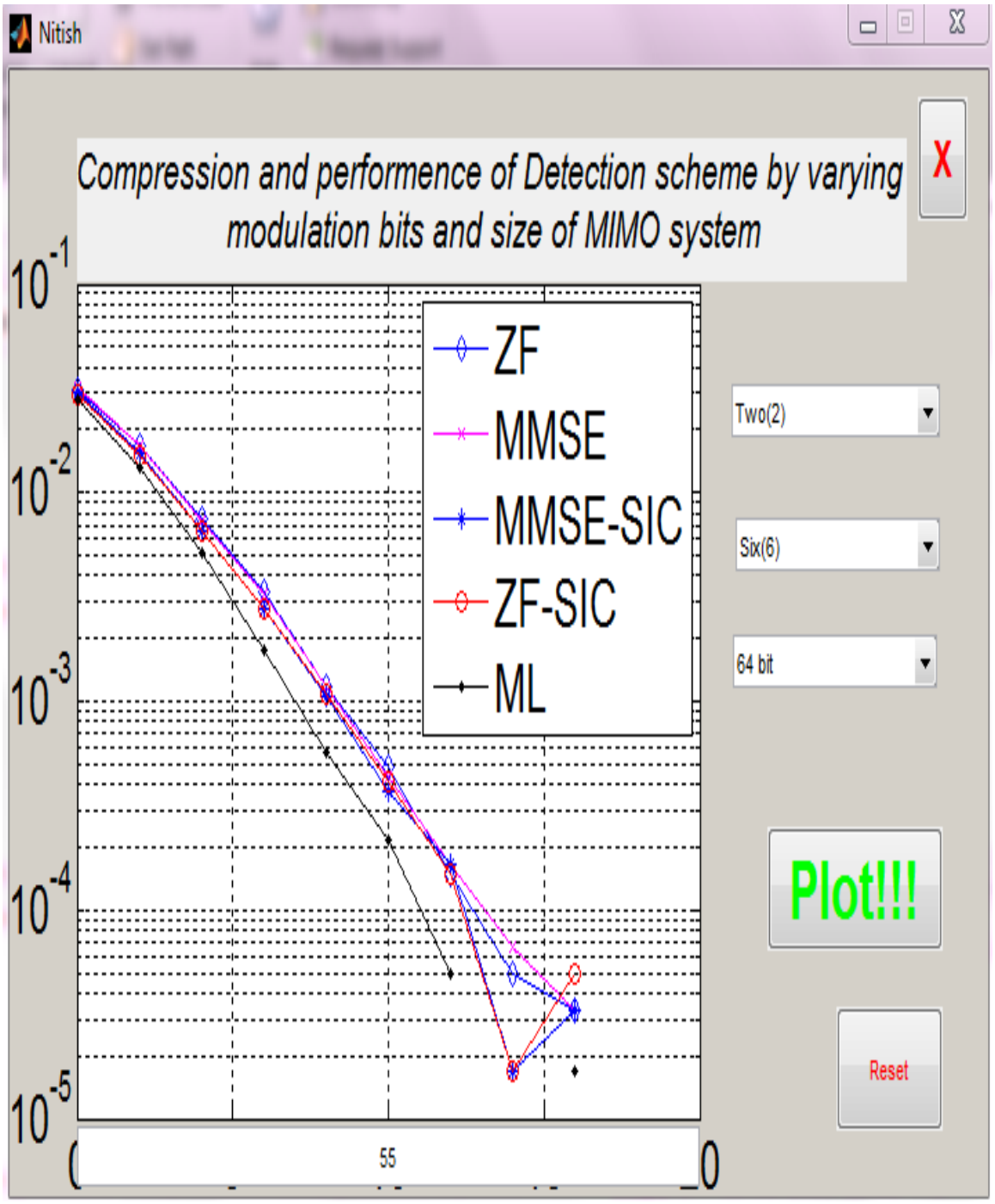

Figure 6.21:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.22 is showing the comparison among all the used techniques .We are taking 4 transmitter and 2 receiver by use 64 bit QAM technique .Among all the technique MMSE-SIC is giving the best results .

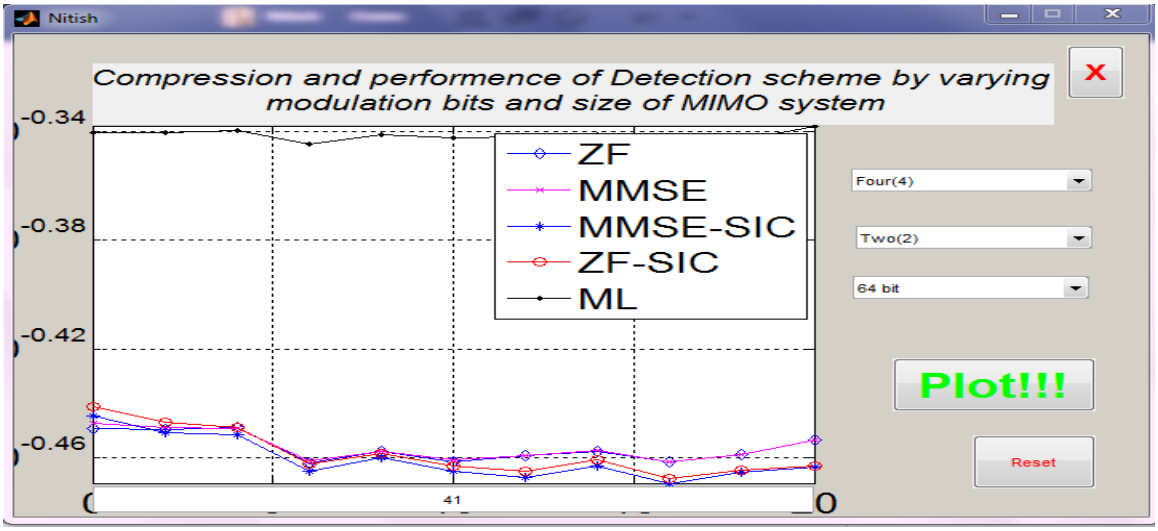

Figure 6.22:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.23 is showing the comparison among all the used techniques .We are taking 4 transmitter and 4 receiver by use 64 bit QAM technique .Among all the technique MMSE-SIC is giving the best results .

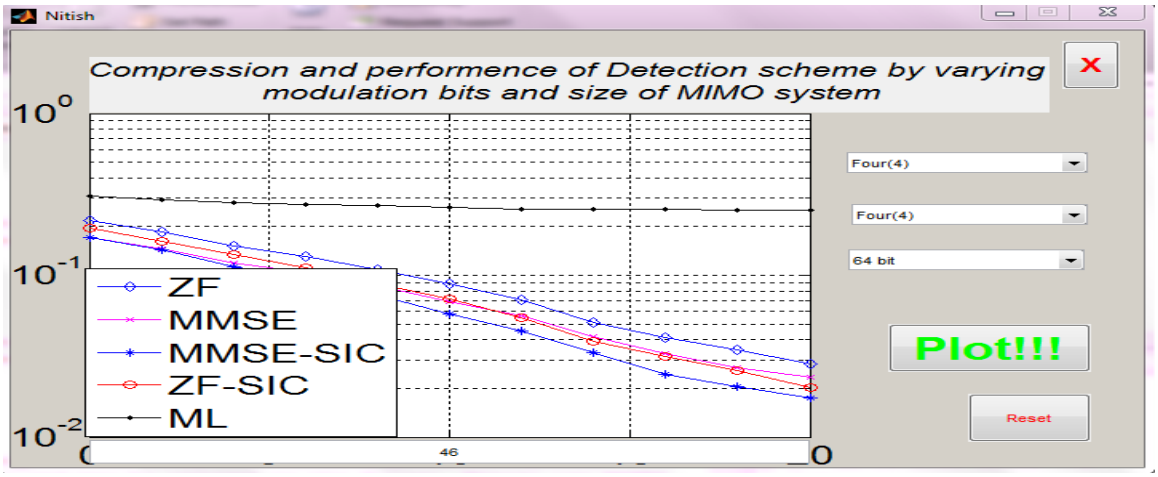

Figure 6.23:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

As the figure 6.24,we are taking 4 transmitter and 6 receiver by use 64 bit QAM technique .Among all the technique MMSE-SIC is giving the best results .

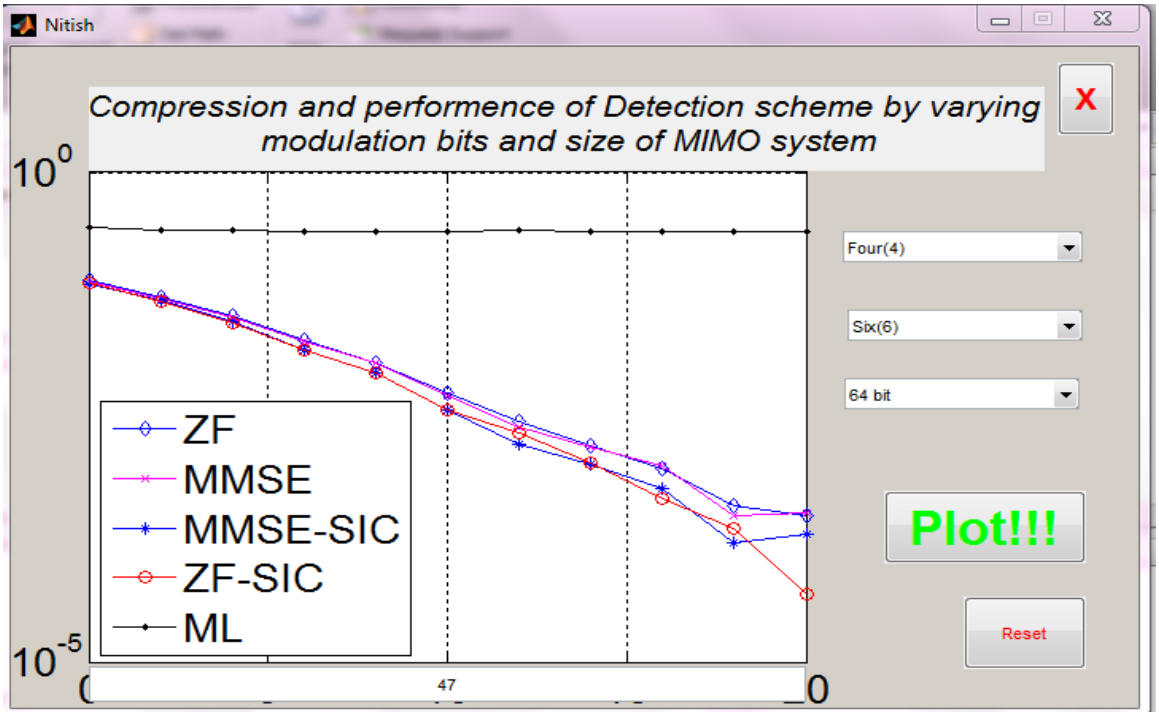

Figure 6.24:- Compression & rendition of schema of Detection by fluctuating bits of modulation & size of system of MIMO

Sr.	Tx.	Rx.	Time	Best Technique
1	2	2	79	ML
2	4	2	70	MMSE-SIC
3	6	2		*
4	2	4	82	ML
5	4	4	66	MMSE-SIC
6	6	4	89	MMSE-SIC
7	2	6		*
8	4	6	82	MMSE-SIC
9	6	6	96	MMSE-SIC

Table 6.3: - 64 bit QAM

In this section, we have illustrated the 16-QAM, 32-QAM, 64- QAM schemes for different detection techniques at various set of channels. The simulations are done for a Rican fading

channel. Here, the simulation is done on MATLAB 2013a deployed application on core i3 processor as per the standards of IEEE802.11a. Table shows the BER performance comparison for a MIMO system with varying transmitting and receiving antenna i.e. Tx=2, 4, 6 and Rx=2, 4,6 for ZF, MMSE, QR, MMSE-SIC, ZF-SIC and ML detection scheme for Rican channel. From the outputs shown, it can be concluded that the value of BER for which detection scheme is low compared to the other detection techniques.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

As MIMO is raising the ways of diversity in communication system and the requirement is also growing with respect to same. In communication system the requirement of both speed and quality are need of current era. And for each parameter there are some predefined guidelines in terms of number of transmitting station, number of receiving station, modulation technique, detection scheme etc. Form above simulation results it can be concluded that it variation also there dependent of both number of antennas and modulation. As talking on number of antennas the result pop-up as that if number of transmitter is fixed to two (2) then using maximum likely hood detection scheme yield lower bit error rate instead number on receiver is raising up to six (6).

The dissertation deals up to six transmitter and receiver. Later the concept can be updated to more number of antennas. In our result one more stuff can be concluded that Minimum Mean Square Error- Successive interference Canceller (MMSE-SIC) produce lower bit error rate if number of antennas (both transmitter and receiver) increase simultaneously. The results of dissertation also yield some good result that signals is not there if modulation is done through 64-Bit and antennas is at more than two. The dissertation can also be updated in terms of modulation schemes; in Quadrature amplitude modulation (QAM) we have higher bits too. Or in order to produce new modulation scheme for higher number of antennas the layout of dissertation can be used