# BER analysis of mimo stbc using various equalization techniques

Farha siddiqui

Abstract— Today is an era of any time any where always on applications meaningfully high speed and high data rate communicating systems. IN todays digital world our communicating systems such as mobile phone ,wireless systems (including LANand bluetooth)3G ,4G all are expected to support a large area of coverage provide higher data rate transmission reduces bit error rate in addition provide high quality multimidea services such as good high quality voice ,video,image and text data. As the radio spectrum in finite so does our demand is minimum usage of spectrum resources and with little transmitted power..MIMO is considered to be the key technology for wireless communication systems.MIMO is promising technology which sounds to to provide higher data rate ,good quality of service with lower bit error rate.MIMO(stands for multiple input multiple output systems) which employs multiple transmit and receive antenna to increase system capacity ,throughput and performance.AS the wireless transmission media is atmosphere(anolog) there are different atmospheric layers as the signal travels from one layer to another there appears to have a degrading effect in quality of signal strength this is termed to be fading effect(i;e)signal is said to be fadded,another issues is when signal moved from multiple path if effect the signal in phase,delay,Doppler Frequency,and channel impulse response all effect the signal i;e the signal which arrive at the receiver is faded.This phenomenon is refered to as fading.Diversity analysis is done to combat the fading effects.Before the signal reaches the reciever and gets demodulated,some equalisation techniques must be perform on the signal so that if combat the effect of fading and i.s.i(inter symbolic interference)which is the main factors which are responsible for (BER).IN this paper different equalisation techniques have been introduced which helps in mitigating the (BER).

Index Terms— *BIT ERROR RATE(BER) ,ISI(INTER SYMBOLIC INTERFERENCE),ZERO FORCING EQUALISATION(Z.F.E),MINIMUM MEAN SQUARE ERROR EQUALISATION(MMSE),MAXIMUM LIKLIHOOD(ML) AND SPHERE DECODING TECHNIQUE(S.D).*



## 1 INTRODUCTION

The MIMO channels allow multiple data stream to be transmitted and to be combined at multiple recieve antennna at the receiver side.the system capacity improvement for a mimo system is linearly propotional to no of antenna.A good analogy for true MIMO systems is parallel computing where different portions of a large numerical simulations are send to different processors,acheiving much higher computational performance than a single processor.. The idea behind MIMO is to design the signals to be sent by the transmit array and the algorithms for processing those seen at the receive array, so that the quality of the transmission (i.e., bit error rate) and its data rate are improved. These gains can be used to provide increased reliability, lower power requirements (per transmit antenna) or higher composite data rates. The essence of space time coding is too combat fading in wireless communication.time coding is done in both spatial and temperoral domain, and thus introducing redundancy between signal transmitted from various antenna at various time periods.Due to these features of space time coding technique it can cheive transmit diversity and antenna gain over spatially uncoded system without sacrifizing bandwidth.the the problem of radio spectrum which is finite in nature has been easily sort out by space timblockcoding.

$$\text{Bit Error Rate, BER} = \frac{\text{Number of errors}}{\text{Total number of bits sent}}$$

As the name implies bit error rate depicts the no of bits received in error by which erroronious bits could be detected. The main reason for the degradation of data channel and the corresponding bit error rate is noise and changes to the propogation path (where radio paths are used). Both effects have random elements to them which degrates the systems performance the performance measure of the system is basically done on three parameters these are error function,,noise power spectral density(psd) that means noise measured per hertz.,and the energy content i n one bit.N higher order modulation scheme(e,g) 64 QAM that are able to carry higher data rate are not as robust in presence of noise,.Lower order digital modulation scheme format(such as phase shift keying specially quadrature phase shift keying (QPSK)in which quadrature increases the bit rate(number of bits transmitted per second)..Thus a high speed system can be acheive by it.

- *Farha siddiqui is currently pursuing masters degree program in digital communication engineering in R.G.T.U University, INDIA, PH-+91-9981491092. E-mail:farahsiddiqui@rocketmail.com*

## 2 FACTORS EFFECTING BIT ERROR RATE(B.E.R)

### 2.1 Interference

THE interference level namely the co channel interferencei; eusing the same frequency in the same network or cells contribute to overall noise of the system and deteriorate the performance.by using multiple antenna,it is possible to supress interference signals what lead to an improvement in system capacity.In terference reduction requires knowledge of the channel of desired signal,but exact knowledge of channel may not be necessary.i

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### 2.2 Increase transmitted power

It is possible to improve the systems performance by increasing the power level ,but the increased power level may interfer with the other users and thus causes adjacent channel interference (ACI).thus side lobes has to be reduced so the additional power may not cause in vicinity of other receiver..if so power is increased which inturn effect the size of power amplifier,battery life time etc.

### 2.3 Reduce bandwidth

Lower level of noise will be received and therefore signal to noise ratio will be improved.again the result in reduction of data throughput attainable.

## 3 MITIGATING TECHNIQUES:

DIVERSITY TECHNIQUE:

To combat fading two or more copies of transmitted signal can be combined at the receiver to increase the signal power.The basic principle is that while some transmitted signal may experience fading,others may not.by using several copies of signal and combining them at receiver the signal power can be increased and system performance enhanced.this is the basic concept of diversity.Diversity take advantageof statistical properties of the time varying communication channel by assuming that the signals combined at the receive experience fading independent of one another.

### CODING TECHNIQUE:

FEC :THE transmitter encode data with an error vcorrecting code and send the codded message.the receiver decode what it receives into the "most likely data" .FEC(forward error correcting codes) are used in current cellular systems such as GSM to protect those bits of coded speech that are more important i n terms of their quality of reproduction.BER(bit error rate are normally be reduced simply by using signal to noise ratio(SNR) at the input of demodulator.The advantage of coding then is that the same BER may be acheived for a lower SNR in a coded system t han in comparable uncoded system.This may allow the power budget to be relaxed,giving a number of potential system advantages.the advantage given by a coded system can be then measured as coding gain.Block codes are used for error detection and correction purposes.Namely Space Time Block codes along with MIMO is an elegant technique to increase the spatial diversityv and introducing higher capacity gain.key features of STBC codes are:*Space Time Block Codes utilise multiple transmit antenna to create spatial diversity.

1.This allow system to have better performance in fading environment.

BENEFITS:

2.Good performance with minimum decoding complexity.

3.Can acheive maximum diversity gain equivalent to space time trelles code..

4.Receivers that employ only linear processing.

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## 5 EQUALIZATION

For an optimum detection of digital signals the main focus is to make the best estimation of the transmitted signal with least probability of errors. ALL the transmitted streams of incoming data are fed into the channel the receiver then take the decession and determine the most probable signal which was transmitted.IN radio wireless communication a variety of equalisers could be used in order to perform the equalisation task namely transversal(having feedforward path)or they may be decission feedback(having forward path) both could be used as per the application to determine the probable transmitted symbol with least probability of errors and cancel interference additionally Since the wireless mobile radio communication is wireless and time varient equalizer must keep a critical view on the radio environment as it is time varying and changing . y.Since the mobile fading channel is random and time varying,equalizer must track the time varying charachteristics of the mobile channel,and thus adaptive equalizers are used.in order to track a slow time varying response adaptive equalizers are used in which tap weight can be adjusted periodically or continually.in order to adjust its filter characteristic over interval of time.The interval of time in which an equalizer converge is a function of equalizer algorithm,the equal;izer structure,and the time rate rate of channel of the multipath radio channel.

## 6 VARIOUS TYPE OF RECEIVERS USED FOR MIMO DECODING

### 6.1 ZERO FORCING RECEIVER:

Zero forcing receiver as the name implies used to bring inter symbolic interference to zero.It comes under the category of linear receiversit gives the optimum performance in noise free case.the main idead behind zero forcing equalizeris to apply inverse purturbation imposed by the channelso in order to counter balance the signal response and nulls out intersymbolic interference.which inturn provide flat frequency response in noise free case.

Zero forcing receiver belong to the group of linear receivers.The zero forcing receiver completely nulls out the influence of the interference signal coming from other transmitter antennas and detect every data stream seperately..Disadvantage of this receiver is that due to cancelling the influence of the signals from other transmit antennas ,the additive noise may be strongly increased and thus performance may degrade heavily.dule to seperate decision of each dat strean,the complexity of this algorithm is lower

### 6.2 Minimum mean square error:

The minimum mean sqquare error receiver comprisesbetween noise enhancement and signal interferenceand minimise the mean square error between the transmitted symbol and detected symbol.thus the result of the mmse equalizerare the transmitted data streams plus noise residual interference and noise.After mmse equalization each data strea is seperately detected (quantized)in the same way as in the Z.F case.Zero forcing equalizer although removes ISImay not the best error performance for the communicating systemsbecause it oes not take into account noise in the system.A (MMSE)equaizer is based on minimum mean square error criterion.A minimum mean square estimator depictsa solution to in a statistical way

To monimise the ISI in a noise case.which is seem to be more robust in high speed applications and in presence of large noise case.The main attraction behind MMSE equalizer is that not all eliminate the noise competely that means nulling unwanted componentr butminimise the total power of noise and ISI component in the output.when noise term is zero minimum mean square error reduces to zero forcing equalizer.

### 6.3 Maximum liklihood sequence estimator:

Maximum liklihood estimator begin with task of after having received the vector(r) is to estimate the transmitted codeword,based on hamming distances the error detection and correction capabilitydepends on minimum distance of codeword for example.

If (dmin=5)

It can correct two errors.Error correcting capability of the code word is defined as the maximum ono og guaranteed correctable error per code word

t=(dmin-1)/2

If dmin=-5 it can correct two errors easily.

By using a mathematical expression known as the liklihood function of the sample data.The liklihood implies as the probability of the sample data.The liklihood implies as the probability of choosing the most likly data sample by following a chossen probability distributiuon model.the value of these parametre that maximises this sample liklihood are known as maximum liklihood estimator.its application includes censored data as well as multi censored data also the more eye catching propertyies includes:

For large sample MLE are optimal.

1. MLE s are asymtotically normally distributed.
2. MLE are asymtotically minimu m variance.
3. MLE are asymptotically unbiased as the sample size increases.

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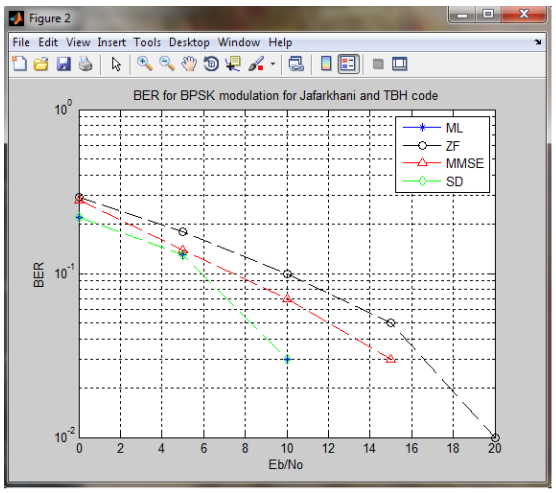
6. MLE are asymptotically unbiased as the sample size increases.
7. Maximum liklihood decoder gives the optimum performance among all decoding receivers.but as all the codewords are checked so thus the computational complexity becomes very high . In order to reduce th e complexity orthogonal space time block codes are used which reduces the exponential complexity to linear complexity at the receiver which in turn makes the decoding easier.
8. If your vector with all possible codewords over an additive white gaussian noise channel



### 6.3 sphere decoder

Sphere decoding is a new type of decoding technique which aims to reduce the computational complexity of the decoding technique.In case of sphere decoder the received signal is compared to the closet lattice point,since each codeword is represented by a lattice point.The number of lattice points scanned by by the sphere decoder is depend on initial radius off the sphere.THE correctness of the codeword is in turn depends on the SNR of the system..The search can easily be ristricted by drawing a circle around the received signal in such an ways as to encompass a fixed no number of lattice points.This entails a search of not all the codewords in the constellation and allows only to those codewords to be checked that happen to fall within the phere.All codewords outside the sphere are not taken into consideration for decoding.THE radius must be chosen in such a way that the values selected must be equal the convering radius of the lattice.The initial radius selected plays critical role in identifying the correct point in the lattice.Ideally noise variance of the system is found and the initial radius of the sphere is adjusted according to signal to noise ratio.This entails the sphere decoder to find at least a signal point inside the phere and prevents the condition of ensure,which is a result of decoding failure.In caseof an erasure the radius of the sphere is increased and decoding again is repeated to gain favorable results.

## 7.END SECTION




Comparrisiion of various receiving techniques(ML receiver,ZERO forcing ,maximum liklihood and sphere decoder)

## 4 CONCLUSSION

The bit error rate performance of sphere decoder is better as compared to maximum liklihood and zero forcing receiver.the performance of sphere decoder is found to be equivalent to maximumliklihood decoder with a benefit of reduced complexity.



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