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Research Article

COMPARATIVE STUDYS OF RECEIVERS IN MIMO USING PYTHON

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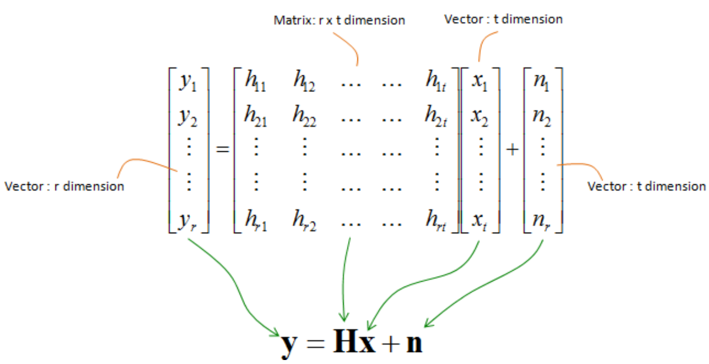
ABSTRACT
This paper compares the receivers in Multiple Input MultipleOutput (MIMO) system which have numerous transmitters andreceivers in source and destination respectively. MIMO transmitter send same information as several signal simultaneously through multiple antenna while using a single radio channel. This is the form of Antenna Diversity which use multiple antennas to improve signal strength and Reduces BER(Bit Error Rate).There are some technique to receive signals from receivers such as Zero Forcing(ZF) receiver, Maximum Likelihood(ML) receiver and Linear Minimum MeanSquare Error(LMMSE) receiver.This paper have the comparison between Zero Forcing receiver and Linear Minimum Mean Square Error receiver , Zero Forcing receiver and Maximum Likelihood receiver.from that comparison we find the which receiver havelow bit error rate (BER).

Keywords: *Mimo, Bit Error Rate, Antenna Diversity, Zf Receiver, Llmse Receiver, Ml Receiver*

INTRODUCTION

MIMO systems utilize multiple antennas at both the transmitter and receiver. The most common form of diversity employed in MIMO systems is the space time diversity, deed both space and time diversity. The Alamouti space time block code is the simplest of the family of orthogonal space timecodes. Along with assorted qualities, MIMO additionally gives multiplexing abilities: permitting clients to transmit diverse images from various transmit antennas, in this manner enhancing the throughput of the system. When using multiple antenna, beam forming reliability will increase. MIMO can also be used to increase data rates. By transmitting multiple information streamsin parallel. This is termed as spatial multiplexing.



Where y is output signal
H is fadingchannel X is incoming signalN is noise factor

ZERO FORCING RECEIVER

Zero Forcing Equalizer refers to a form of linear equalization algorithm used in communication systems which applies the inverse of the frequency response of the channel. The Zero-Forcing Equalizer applies the inverse of the channel frequency response to the received signal, to restore the signal after the channel. The name Zero Forcing corresponds to bringing down the intersymbol interference (ISI) to zero in a noise free case. This will be useful when ISI is significant compared to noise.MIMO system that employs zero-forcing (ZF) receiver and pilot reuse. Although with infinity number of antennas it has been shown that maximum ratio combining (MRC) attains the same throughput as ZF, we find that for antenna number as large as 100, ZF attains significant throughput gain over MRC. A tight lower bound is derived for cell throughput attained by ZF, characterizing three interference terms: intra-cell interference, inter-cell interference, and interference due to pilot contamination, where the three interference regimes of ZF are compared against with MRC. Numerical simulations are conducted to gain insight for the relation among the optimal cell throughput, pilot reuse number, number of base station antennas and the network topology. Extension to arbitrary network typologies are briefly discussed.

For a channel with frequency response F(f) the zero forcing equalizer C(f) is constructed by:C(f)=1/ F(f)

Thus the combination of channel and equalizer gives a flat frequency response andlinear phase .

F(f) C(f)=1

In reality, zero-forcing equalization does not work in some applications, for the following

Even though the channel impulse response has finite length, the impulse response of the equalizer needs to be infinitely long. At some frequencies the received signal may be weak. To compensate, the magnitude of the zero-forcing filter ("gain") grows very large. As a consequence, any noise added after the channel gets boosted by a large factor and destroys the overall signal-to-noise ratio. Furthermore, the channel may have zeroes in its frequency response that cannot be inverted at all. Zero Forcing precoding is a method of spatial signal processing by which a multiple antenna transmitter can null the interference MIMO wireless communication system.

In telecommunication, Intersymbol interference (ISI) is a form of distortion of a signal in which one symbol interferes with subsequent symbols. The presence of ISI in the system introduces errors in the decision device at the receiver output. Therefore, in the design of the transmitting andreceiving filters, the objective is to minimize the effects of ISI, and thereby deliver the digital data to its destination with the smallest error rate possible. In this paper, we design a zero forcing equalizer, which is a type of linear equalizer used to mitigate the effects of ISI (Inter symbol Interference).

The Zero Forcing (ZF) receiver minimizes the errorMin$||y-Hx||^2$

The estimation of symbol vector is $|\hat{x}| = (H^H H)^{-1} H^H y$

The quality (H^H H)^-1 is termed as the pseudo inverse of H (H^H*H)^-1H^H=I

BER is identical to MRC with L=r-t+1

$$\text{BER} = \frac{1}{2^L} C^{2L-1}_{L} \left(\frac{1}{SNR}\right)^{L}$$

Consider 4 × 2 MIMO System

SNR = 20 dB = 100. What is the BER?

Given

r = 4, t = 2

L = r − t + 1 = 3

$$\text{BER}=5C_3 * \frac{1}{2^3} * \frac{1}{100^3}$$

=1.25*10^-6

LINEAR MINIMUM MEAN SQUARE ERROR (LMMSE) RECEIVER

To minimize the intersymbol interference and additive noise effects, the equalizer coefficients can be optimized using the minimum mean squared error (MMSE) criterion. When the SNR has elevated values the MMSE equalizer works as Zero Forcing does, but when the SNR has lower values, the fact that MMSE equalizer takes into account the noise and signal variance, makes to not amplify the noise as Zero Forcing does. when the Signal to Noise Ratio (SNR) has high values, the MMSE equalizer works as the Zero Forcing does, but for the rest of values that SNR can take, the MMSE equalizer works better in terms of distortion.This equalizer does not amplifies the received signal just multiplying for the inverse of the channel, it takes into account the SNR in order to not amplify so much the noise term. This is the big difference about the two equalizers and it can be clearly appreciated in the deep nulls of the channel.While Zero Forcing equalizer increases significantly the noise term in order to recover the original signal, MMSE does not do.

Minimum mean of the squared error

Min E $\{\|\hat{X} - X\|^2\}$

Let us assume the symbols x to be iid zero mean with power ETherefore the transmit covariance matrix is $E\{xx^H\}=E_S I$

At E\NO , the LMMSE receiver for the MIMO system is given as

$$\hat{x} = \left(\frac{N_0}{E_s} I + H^H H\right)^{-1} H^H y$$

At high SNR, LMMSE act as a ZF receiver

MAXIMUM LIKELIHOOD RECEIVER

Linear least squares estimation techniques can be used to enhance suppression of narrowband interference in direct sequence spread spectrum systems. Nonlinear techniques for this purpose have also been investigated recently. we derive maximum likelihood receivers for direct sequence signal Gaussian interference with known second order characteristics. It is shown that if the receiver uses samples from outside the bit interval, then the receiver structure is nonlinear. The bit error rate performances of these receivers are compared to those of linear receivers employing one- sided and two-sided least squares estimation filters, for the case of Gaussian autoregressive interference. The maximum-likelihood (ML) receiver for binary data, additive Gaussian noise, and nearest-neighbor inter symbol interference (ISI) is shown to be a matched filter followed by a feedback loop and a tapped delay line. The loop and the tap connections contain nonlinear amplifiers, each saturating at the level of the ISI. This receiver minimizes the persymbol probability of error P e ; upper and lower bounds on P e are obtained.

Maximum Likelihood estimation (MLE) is an important tool in determining the actual probabilities of the assumed model of communication. In reality, a communication channel can be quite complex and a model becomes necessary to simplify calculations at decoder side. While increasing the efficiency, the optimum multiuser receiver consisting of a front-end followed by a detector has a considerable complexity. Generally, the optimum receiver such as maximum-likelihood (ML) multiuser receiver suffers from the exponentially increased complexity (with the number of users) and is considered too complicated to be practical. To reduce the complexity, some suboptimum receivers were proposed [7]. The main strategy is simplifying the detector at the expense of acceptable performance loss in terms of bit error rate (BER).

The ML receiver for a MIMO system can be described as followsX= arg min||y-Hx||^2

The minimization is over all vectors belonging to the transmit constellation S has four different combinations.

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For instance for t=2 and BPSK constellation is The constellation size is |s|=m^t
where each symbol is drawn from M –ary QAMFor M=16 and t=4,this becomes
|s|=16^4=65,536

Thus complexity increase exponentially Unsuitable for large MIMO systems

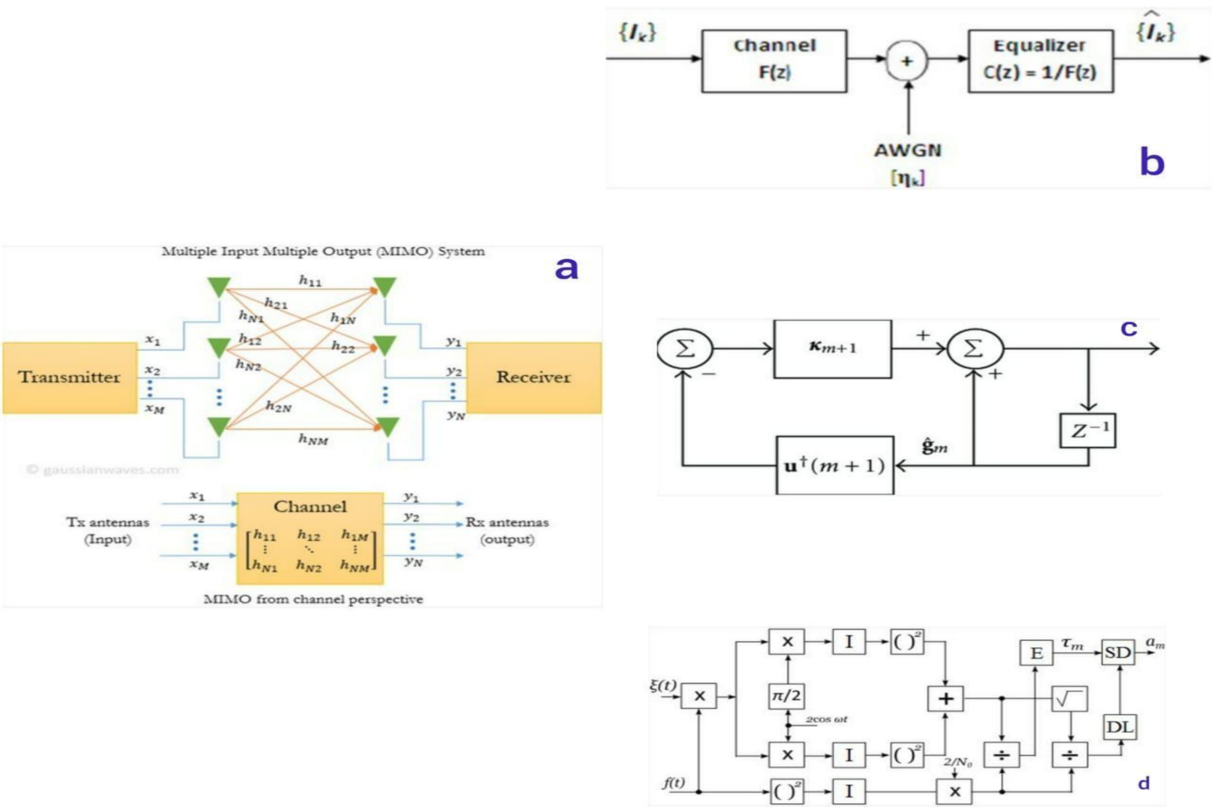

Figure 1: a-block diagtam of MIMO,b-zero forcing technique,c-Linear Minimum Mean Square Error technique, d-Maximum Likelihood technique

RESULT AND DISCUSSION

The comparison which have by this paper is done by python (spyder) software. The first comparison is between Zero forcing receiver and Linear Minimum Mean Square error receiver. For this comparison, program import the librariesn such as numpy, matplotlib, which used to provide graphical output. Intialize the some parameters. Number of symbols per block is 1000,and we have 10000 number of block. There are two receiver antenna and two transmitter antenna in sender and destination. we get energy per bit by using formals .the transmitted signals are modulated by QPSKquadrature phase shift keying.

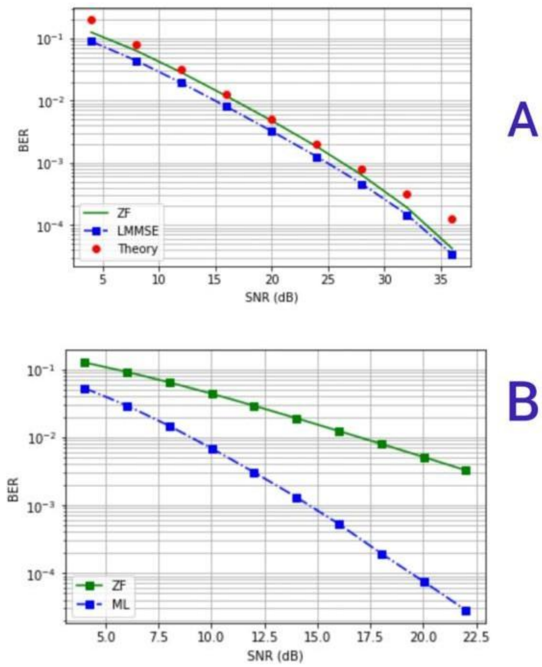

Figure 2: A-comparison between Zero Forcing receiver and Linear Minimum Mean Square Error receiver, B-comparison between Zero Forcing receiver and Maximum Likelihood receiver

From the graph A, we come to conclude that linear minimum mean square receiver have low bit error rate than the Zero forcing receiver.

By comparing Zero Forcing receiver and Linear Minimum Mean Square Error receiver,we found LMMSE receiver have low bit error rate.

From the above graph B, we come to conclude that Maximum likelihood receiver have low bit error rate than the Zero forcing receiver.

By comparing Zero Forcing receiver and Maximum Likelihood receiver, we found Maximum Likelihood receiver have low bit error rate.

From the above comparisons, Maximum likelihood receiver have low bit error rate than Zero forcing reciver and linear minimum mean square error receiver.

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