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BER REDUCTION USING ZF-SIC AND MMSE-SIC ALGORITHM IN LTE-A NETWORK

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ABSTRACT:

Wireless broadband communication has gained attention due to ever growing demands of multimedia and internet services. The major challenges faced by wireless communication are availability of resources like bandwidth and transmission power. Also the wireless channel suffers from impairments like fading. Frequency Division Multiplexing (FDM) based subcarrier Channel impairments must be mitigated at the receiver by using equalization techniques. In these concept BER performance is minimized improvements of OFDM systems using different equalization techniques such as Zero forcing (ZF), Minimum mean square error (MMSE) with successive interference cancellation are done over cooperative decode and forward relaying network. Simulations are carried out under Rayleigh frequency flat channels with the throughput rate analysis

1. INTRODUCTION:

Third-Generation (3G) wireless systems have been deployed on a broad scale around the world to provide enhanced downlink (DL) and uplink (UL) transmissions. However, due to the emerging technologies and evolving Quality of Service (QoS) requirement, future-generation wireless communication systems are expected to meet even more challenging demands of high data rate and reliable multimedia communications. As a consequence, the Third Generation Partnership Project (3GPP) has launched the long-term evolution (LTE) standard of 3G for wireless communications. The target is to enable high speed data transmission for mobile phones and data terminals at substantially reduced compared to current radio access technologies In order to improve the spectrum efficiency,the physical layer technologies specified in LTE Release 8 incorporate new techniques such as Orthogonal Frequency Division Multiplexing (OFDM) as the DL multiple access scheme and Single-Carrier Frequency Division Multiple Access (SC-FDMA) as the UL scheme. Currently, further enhancements are being studied to improve the existing LTE Release 8 standard. These enhancements are included in LTE-Advanced (also known as LTE Release 10) standard, which is targeted to support much higher peak rates, higher throughput and coverage, and lower latencies, resulting in a better user experience. Successive Interference Cancellation (SIC**)** is a well known physical layer technique. SIC is the ability of the receiver to receive two or more signals concurrently (that otherwise cause a collision in today's system.

Scheduling in wireless ad hoc networks determines the set of transmitter and receiver pairs i.e., links, to be activated in any given time .The scheduling algorithm avoiding the overlap in time and space however limit the capacity of wireless ad -hoc networks [1].Interference avoidance model that allows the receiver to only decode only one transmission at a time by considering all other transmission as interference has been widely used in scheduling algorithm .The Zero Forcing Equalizer removes all ISI and is ideal when is noiseless .When the channel is noisy the zero forcing equaliser give the channel response H(j2πf) by amplifying at the frequency f and has a small magnitude in the attempt to invert the channel completely .A more balanced Minimum Mean Square Error(MMSE)equalizer which doesn't usually eliminate ISI completely but instead minimizes the total power of the noise and ISI component in the output [2].In [3],the author considered a mmse receiver and develop receive selection algorithms to maximize thechannel capacity which again need not be optimal as far as error performance is concerned .In fact such schemes perform only slightly better than deterministic antenna selection .Therefore it is essential to model antenna selection problem with the aim of minimizing the error rate of the link taking receiver processing into consideration ,this issue is appeared in [4,5]. In [6] authors proposed transmit antenna selection strategy for ZF receivers to moderate the effect of transmit antenna correlation .In [6] the authors also presented a transmit antenna selection algorithm and later in [7] extended it to lattice reduction aided (LRA) ZF receivers, which have additional complexity compared to traditional ZF receivers .The analysis in [4,5] is limited to single user and in [7,8] antenna selection is considered only at the transmitter .Moreover no exact analysis is provided for the mmse receiver ,which is known to how much superior performance than the ZF receiver at low and moderate SNR.

The remaining of these papers is as follows: the Proposed algorithm is explained in section 2.Step implementation of proposed algorithm is explained in section 3.Simulation results are discussed in section 4.conclusion is given in section 5. References are given in section 6.

2. PROPOSED ALGORITHMS

Drawbacks of existing algorithm: ZF, at some frequencies the received signal may be weak. To compensate this weak signal the magnitude of the ZF filter grows very large. Due to this compensation some additional noise is added after the channel gets boosted by a large factor and destroy the overall signal-to-noise-ratio .when compared to existing algorithm ZF and MRC our proposed algorithm ZF-AIC and MMSE algorithm greatly reduces the bit error rate and increasing the signal-to-noise-ratio

2.1 Zero Forcing with SIC Algorithm

Zero forcing receivers [5] are a Simple linear MIMO receiver, with low computational complexity. It minimizes the interference but suffers from noise enhancement. ZF receiver works best with high SNR level. It is based on the calculation of inverse of channel matrix H.

y = H(x) + n - - - - - - - - - - - - - - (1)

To solve for x, we need to find a matrix W which satisfies WH = I. The Zero Forcing (ZF) detector for meeting this constraint is given by,

W = (HHH)-1 HH - - - - - - - - - - - - -(2)

Where , W - Equalization Matrix and H - Channel Matrix

2.2. Minimum Mean Square Error with SIC Algorithm

A minimum mean square error (MMSE) estimator approach minimizes the mean square error (MSE), which is a common measure of estimator quality. The main feature of MMSE equalizer is that it does not usually eliminate ISI completely but, minimizes the total power of the noise and ISI components in the output. Let x be an unknown random variable, and let y be a known random variable. An estimator x^ (y) is any function of the measurement y, and its mean square error is given by

MSE = E {(X^ -X2)} - - - - - - - - - - - - - (3)

where the expectation is taken over both x and y. The MMSE estimator is then defined as the estimator achieving minimal MSE. In many cases, it is not possible to determine a closed form for the MMSE estimator. In these cases, one possibility is to seek the technique minimizing the MSE within a particular class, such as the class of linear estimators. The linear MMSE estimator is the estimator achieving minimum MSE among all estimators of the form AY + b. If the measurement Y is a random vector, A is a matrix and b is a vector. The Minimum Mean Square Error (MMSE) approach tries to find a coefficient W which minimizes the criterion is given by,

$\boldsymbol{E} = \{[\boldsymbol{Wy} - \boldsymbol{x}][\boldsymbol{Wy} - \boldsymbol{x}]\boldsymbol{H}\}$ - - - -- - - (4)

Where,

W - Equalization Matrix , H - Channel Matrix , n - Channel noise , y- Received signal.

To solve for x, we need to find a matrix W which satisfies WH =I. The Minimum Mean Square Error (MMSE) detector for meeting this constraint is given by,

$\boldsymbol{W} = [\boldsymbol{HHH} + \boldsymbol{NoI} - \boldsymbol{1HH}]$ - - - - - (5)

At very high SNR level decor relator completely suppress the interference, therefore it provides better performance at higher SNR level. Now in low SNR level condition, the maximal ratio combining receiver provides better performance. Therefore in order to design an optimal receiver it is necessary to converge these two advantages in a single receiver. In MMSE receiver these two features are optimally combined. MMSE receiver is another type of linear detector which minimizes the mean squared error between the transmitted symbols. MMSE detector helps to jointly minimize both the noise and interference or we can say that the MMSE detector seeks to balance between cancellation of the interference and reduction of noise enhancement. Therefore MMSE detector outperforms the ZF detector in the presence of noise.

3. IMPLEMENTATION OF PROPOSED ALGORITHMS

3.1 Steps in Zero Forcing with SIC Algorithm

Step1: Ordering-to determine the transmitted stream with lowest error variance.
Step2 : Interference Nulling - Estimation of the strongest transmitted signal by Nulling out all weaker signals.
Step 3. Interference cancellation - Demodulate the data bits, subtract their contribution from the received signal vector and return to the ordering step.

3.2 Flowchart for ZF-SIC

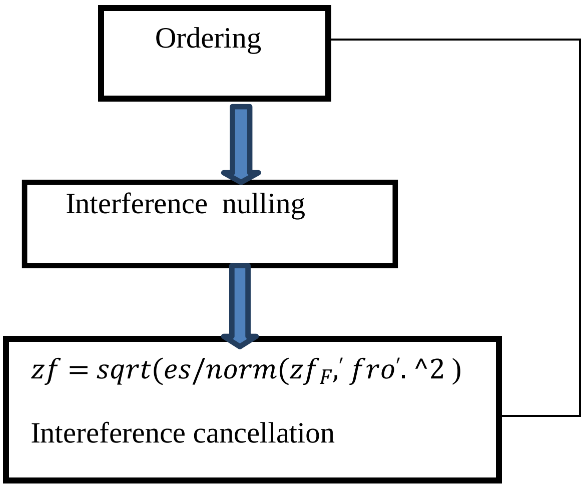

Fig 1:Flow chart for ZF-SIC algorithm

3.3.Steps in Minimum Mean Square Error with SIC:

Step 1: MMSE detection

Step 2:information of input vector based on the received signal on each dimension

Step 3:sorting the group vector from input vector

Step4:

$$MMSE\_SIC=\left(\frac{es}{norm(mmse_F,'fro')}.^2\right)$$

Step 5: Removal of noise as well as ISI effect based on group vector in order
Step 6: Best possible group vector selection according to SNR

Step 7: Hard decision decoding at receiver
Step 8: Error counting

3.4.Flow chart for MMSE-SIC

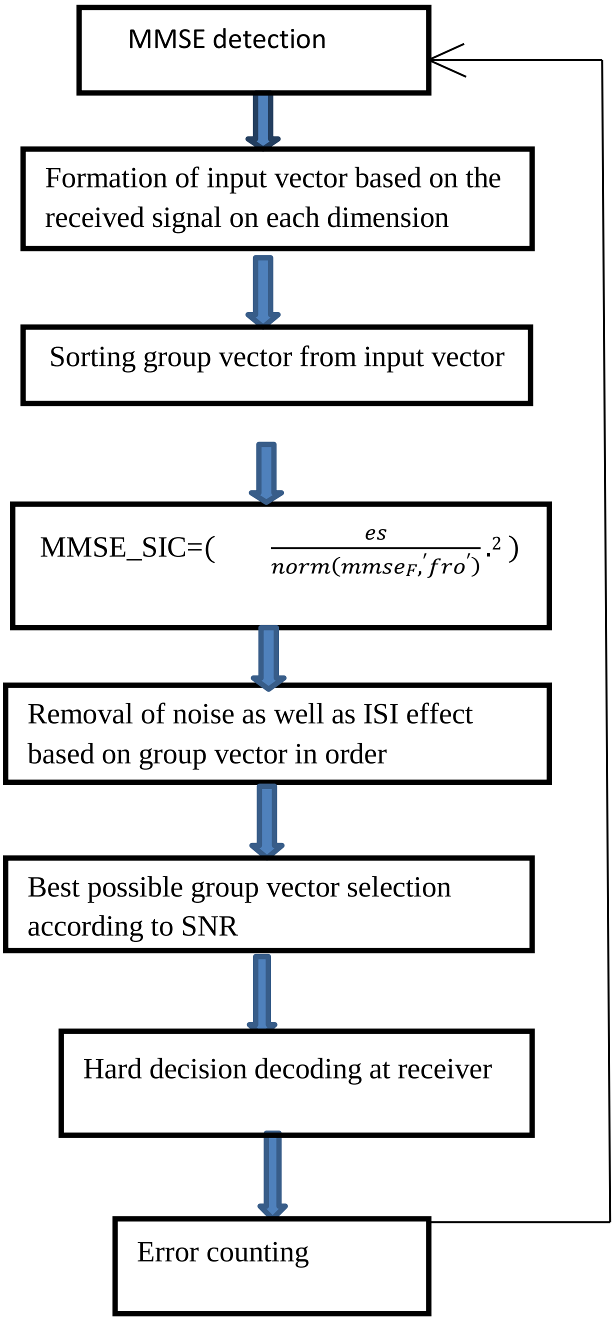

Fig. 2. Flowchart for MMSE-SIC Algorithm

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4.SIMULATION RESULTS AND DISCUSSIONS

The required parameters for the proposed algorithm are given in the following table 1

Table. 1.

S.no	Parameteres	Range
1	Matlab version	matlabR2014a
2	SNR	0-10db
3	Number of transmitter and reciever	2
4	FFT size	64
5	Number of subcarrier	52
6	Number of bit per symbol	52
7	X axis	SNR(db)
8	Y axis	BER

4.1.Simulation Results

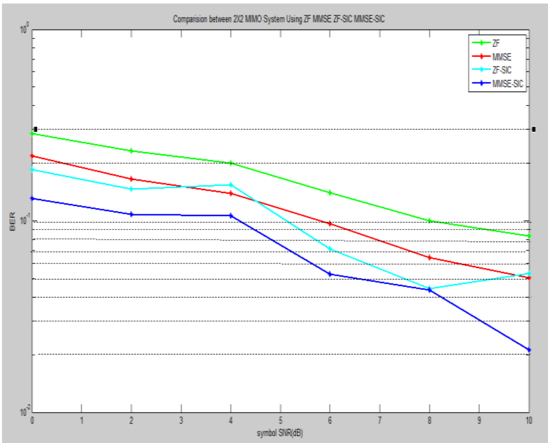

Figure 3 shows that the BER analysis 2×2 MIMO using QAM 64 for ZF- SIC and MMSE- SIC

The values of SNR plotted in X axis and BER values are plotted in Y axis. When the SNR is equal to 0 the BER value of MMSE-SIC(blue)is 0.1582 and ZF-SIC(light blue) is 0.2199-0.0050i .As SNR value is increased linearly , the BER value get decreased At SNR is equal to 10 .BER of MMSE-SIC is0.0987 and ZF-SIC is 0.1381-0.0067i.comparing all these equalizers(ZF,MMSE,ZF-SIC,MMSE- SIC), MMSE-SIC has the minimum BER

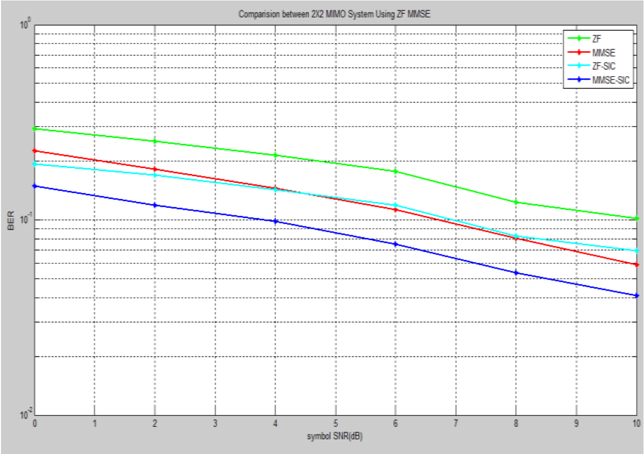

Figure 4 BER analysis 2×2 MIMO using BPSK for ZF MMSE ZF-SIC MMSE-SIC

The values of SNR plotted in X axis and BER values are plotted in Y axis. When the SNR is equal to 0 the BER value of MMSE- SIC(blue)is 0.1398 and ZF-SIC(light blue) is 0.1893+0.0015i .As SNR value is increased linearly , the BER value get decreased At SNR is equal to 10 .BER of MMSE-SIC is0.0841 and ZF-SIC is 0.1203+0.0005i.comparing all these equalizers(ZF,MMSE,ZF-SIC,MMSE- SIC), MMSE-SIC has the minimum BER

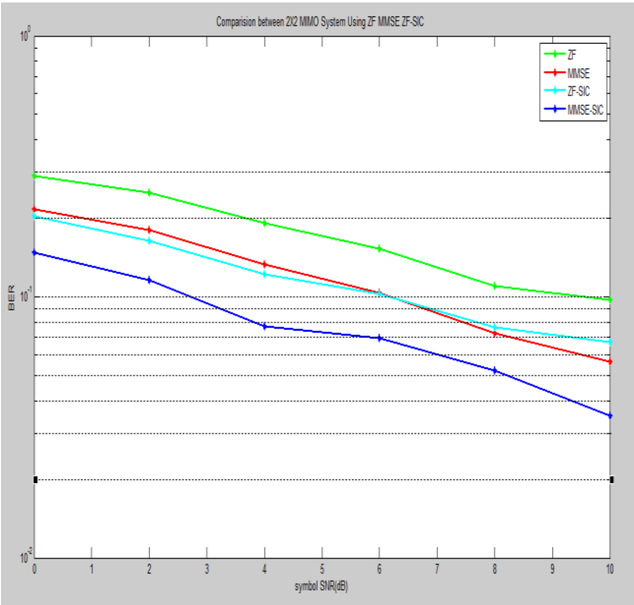

Figure 5 BER analysis 2×2 MIMO using QAM 16 for ZF MMSE ZF-SIC MMSE-SIC

The value of SNR is plotted in X axis and BER values are plotted in Y axis. When the SNR is equal to 0 the BER value of MMSE- SIC(blue)is 0.1467 and ZF-SIC(light blue) is 0.1969-0.0013 i .As SNR value is increased linearly , the BER value get decreased At SNR is equal to 10 .BER of MMSE-SIC is0.0828 and ZF-SIC is 0.1189+0.00361i.comparing all these equalizers(ZF,MMSE,ZF-SIC,MMSE- SIC), MMSE-SIC has the minimum BER

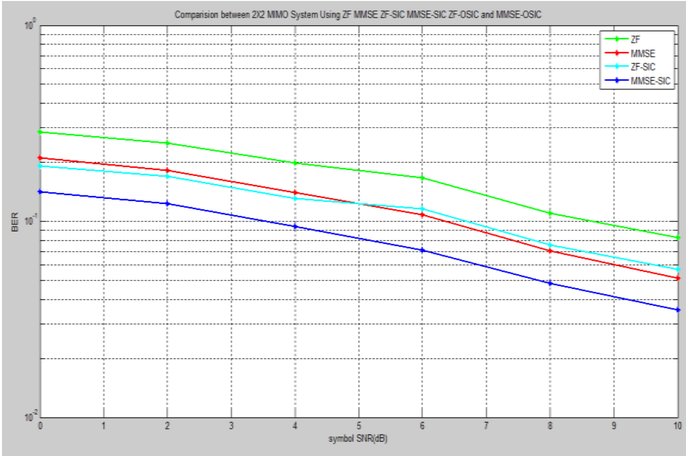

Figure 6 BER analysis 2×2 MIMO using QPSK for ZF MMSE ZF-SIC MMSE –SIC

SNR plotted in X axis and BER values are plotted in Y axis. When the SNR is equal to 0 the BER value of MMSE-SIC(blue)is 0.1476 and ZF-SIC(light blue) is 0.1948+0.0034 i .As SNR value is increased linearly , the BER value get decreased At SNR is equal to 10 .BER of MMSE-SIC is0.0808 and ZF-SIC is 0.1230+0.0014i.comparing all these equalizers(ZF,MMSE,ZF-SIC,MMSE-SIC),
MMSE-SIC has the minimum BER.

S.no	**Parameteres**	**Range**
1	Matlab version	matlabR2014a
2	SNR	0-10db
3	Number of transmitter and reciever	2
4	FFT size	64
5	Number of subcarrier	52
6	Number of bit per symbol	52
7	X axis	SNR(db)
8	Y axis	BER

5. CONCLUSION:

In this paper we investigated about the BER performance analysis of ZF-SIC, MMSE-SIC MIMO receivers. Here we give MMSE-SIC performance by using different methods of modulation such as QPSK,BPSK,QAM- 16,QAM-64.For consideration 10dB SNR ,the performance of MIMO system with MMSE-SIC receiver by QPSK modulation provide better overall system performance with increasing diversity order than ZF-SIC. The BPSK transmits one bit per symbol and it requires 2f bandwidth while QPSK transmits two bit per symbol which utilizes half the bandwidth of BPSK. Even though QAM has the efficient usage of bandwidth, this modulation is more susceptible to noise, so the QAM receiver is more complex compared to other modulation receiver systems. By analyzing all the four modulation (QAM64, QAM16,BPSK,QPSK) QPSK has the lowest BER.

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