Performance evaluation with effective error cancellation technique using QPSK in WCDMA.

Miss Neeraj Malik[1] Naveen Kumar Malik[2] Ms. Babita[3]

ECE,B.M.I.E.T., Sonipat, India[1,3] ECE, Hindu College of Engg., Sonepat, India[2]
s.neerumalik@gmail.com[1,3], naveenmalik4u@gmail.com[2]

Abstract.In this paper a comparative performance evaluation study has been made on V-BLAST (Vertical Bell Labs Layered Space-Time) encoded MIMO(multiple input multiple output (4*4)) WCDMA(wideband code division multiple access) wireless communication system. which applied on encrypted synthetically generated binary data transmission using MMSE(Minimum mean square error[4]),ZF(zero-forcing[7]),SIC(sucessesive interference cancelliation[23]) and ML (Maximun Liklihood[1]) channel equillization scheme.these techniques used for linear detectors in fading channels with different antenna selections for QPSK digital modulation technique.

Two new hybrid effective error cancelliation technique are given in which combination of the ZF+SIC and MMSE+SIC are used to achieve the lowest bit error rate. we present some simulation results with Matlab based on the parameters[Table-1] & shows performance of Zero forcing technique and minimum mean square estimation with the successive interference cancellation is equal to the maximum likelihood technique.

Keywords:
WCDMA,MIMO System ,AWGN ,Bit error rate(BER),Interference ,ZF,MMSE,SIC,ML.

1.1 Introduction of MIMO System

A Systems has multiple transmit and multiple receive antennas are commonly known as multiple input multiple output (MIMO) systems. This wireless networking technology greatly improves both the range and the capacity of a wireless communication system. MIMO systems pose new challenges for digital signal processing given that the processing algorithms are becoming more complex with multiple antennas at both ends of the communication channel. MIMO systems constructively explore multi-path propagation using different transmission paths to the receiver. These paths provide redundancy of transmitted data, & improve the reliability of transmission or increasing the number of simultaneously transmitted data streams and increasing the data rate of the system (multiplexing gain). A general model of a MIMO system is shown in Fig. 1.[2].

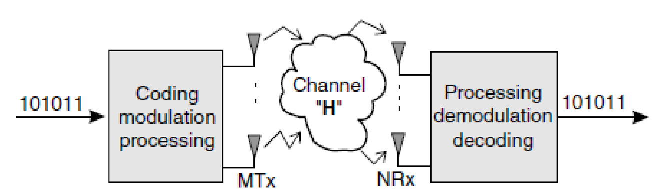

Fig. 1 A general block diagram of a multiple input multiple output wireless communication system.[2]

The capacity of the systems can increase linearly with the number of transmit antennas as long as the number of receive antennas. As an increase in capacity means capability of faster communication, this unmatched capacity improvement over regular one-antenna systems has fueled a huge interest in MIMO techniques, thus leading to the development of many forms of MIMO systems.

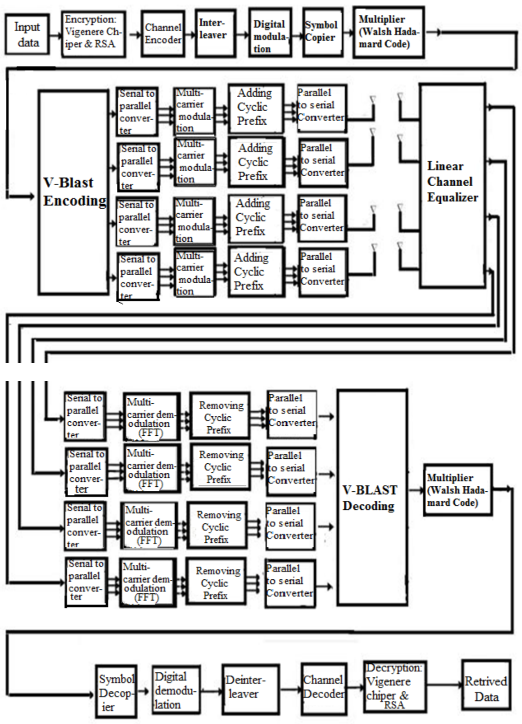

Figure 2.Block diagram of a V-Blast encoded MIMO WCDMA wireless communication system[1].

1.2Introduction of linear channel equalisation scheme

The asymptotic performance of maximum likelihood (ML) channel estimation algorithms in wideband code division multiple access (WCDMA) scenarios. Here we study a systems with periodic spreading sequences (period larger than or equal to the symbol span) here transmitted signal is code division multiplexed pilot for channel estimation purposes, in this semi-blind conditional maximum likelihood (CML) and semi-blind Gaussian maximum likelihood (GML) channel estimators are derived. And formulas are simplified by considering a randomized spreading and training sequences which is of high spreading factors and high number of codes. The results provide a useful tool to describe the performance of the channel estimators as a function of basic system parameters such as number of codes, spreading factors, or traffic to training power ratio[7].

The uplink coverage and capacity of CDMA cellular systems with the conventional single user detector receiver are depending on interference in that system Particularly, during the roll–out phase, the coverage of a CDMA system is uplink limited. So by using serial interference cancellation (SIC) on the base station is best method to increase the performance. This mathosd has low cost.let us Consider the typical quality of service requirements of mixed services is provided.these service are voice & data. A new hybrid receiver structure for interference cancellation is proposed. For analysis of system performance, the calculation of signal–to–interference ratios is extended to the case of multiple service classes with various SIC receiver structures. According to it the optimum powers of the mobile stations are derived as a function of various system and design parameters. It provide an accurate calculation of the both interference (intercell & intracell).including these analytical expressions are derived for the coverage–capacity tradeoff. Results show significant performance gains in terms of user capacity and cell coverage by using SIC receivers including the proposed hybrid structure[5] .

In a comperative evaluation study has been made on a V-Blast encoded MIMO MCCDMA wireless communication system by using encrypted synthetically generated binary data transmission. It uses Minimum Mean Square Error (MMSE) and Zero- Forcing (ZF) Linear channel equalization schemes. A wireless communication system uses two channel encoding schemes (1/2-rated Convolutional and CRC) under BPSK,DPSK, QPSK and QAM digital modulations technique. In this simulation system, synthetically generated binary data transmission has been secured with concatenated implementation of Vigenere Cipher and RSA cryptographic algorithm. It is concluded that results of BPSK modulation outperforms as compared to DPSK, QPSK and QAM modulation schemes in MMSE channel equalization and V-BLAST based 1/2-rated Convolutional channel Encoded MIMO MCCDMA schemes under AWGN channels. For ZF channel equalization and CRC channel coding, the system shows identical performance. For both cases, QPSK digital modulation shows worst performance. It is noticeable from the present study that the ZF with ½-rated Convolution coding scheme is superior as compared to MMSE with CRC coding scheme for BPSK digital modulation

1.3 Methodology

This detection of signal is done by using linear combinatorial nulling techniques like MMSE & ZF or non-linear methods such as symbol cancellation mathod. Here every sub stream is considered to be the desired signal and all the others are as a interferers. Nulling is provided by linearly weighting (W) the received signals. The MIMO system requires multiple antennas at both ends of radio link. It increases data rate by transmitting independent information streams on different antennas.

steps

1. Declaration of Parameters such as number of transmitters and receivers, frame length.
2. Declaration of input SNR range.
3. Calculation of effective SNR.
4. Generation of input data b-y considering frame length.
5. QPSK baseband modulation of input data.
6. Generation of AWGN complex values as the size of input data.
7. Mixing of AWGN with modulated input data.
8. Implementation of all four detectors (ML, MMSE, ZF and SIC) by inputting of noise corrupted data.
9. Demodulation of the data from the channel.
10. Calculation of number of error bits so as to calculate BER or error probability.
11. Plot of Error probability vs. SNR for each detector.
12. Comparison of results.

1.4 Effective Error Cancelliation Technique

Here for detection we use linear & nonlinear nulling technique linear combinational technique are ZF & MMSE. & non linear mathods are symbol cancelliation technique. Here each sub stream is considered to be the desired signal and all the others are interferers. Nulling is achieved by linearly weighting (W) the received signals. The MIMO system requires multiple antennas at both ends of radio link. It increases data rate by transmitting independent information streams on different antennas.

1.3.1.Main Steps for Effective error cancelliation Technique

1. Ordering: select a best channel .

2. nulling :done by using linear techinque (such as ZF, MMSE, ML).

3. Slicing: taking a symbol decision

4. Canceling: subtrat the detected symbol from other symbol

5. Iteration: going to the first step(again ordering) for detection of next symbol.

The detection process consists of two main operations:

1. Interference suppression (nulling): The suppression operation nulls out interference by projecting the received vector onto the null subspace (perpendicular subspace) of the subspace spanned by the interfering signals. After doing this a , normal detection of the first symbol is performed.
2. Interference cancellation (subtraction): The contribution of the detected symbol is subtracted from the received vector.

1.5.MATHEMATICAL MODEL

In our presently considered secured V-BLAST scheme implementation based MIMO (4× 4)WCDMA Wireless communication system, Vigenere Cipher and RSA cryptographic algorithms and two channel equalization

1.5.2PARAMETERS FOR SIMULATION SETUP

The present study has been conducted with consideration of parameters presented in Table1.

Parameter	Values
Synthetically generated binary data (bits)	1200
Modulation	QPSK
Linear Channel Equalization Scheme	Minimum Mean Square Error (MMSE) and Zero- Forcing (ZF),Sucssesive interference cancelliation(SIC),Maximum likelihood(ML)
Antenna configuration	4 × 4
Channel	AWGN
Signal to noise ratio, SNR	0 to20 Db

Table 1. Summary of the simulated model parameters

1.5Results and Discussions

In this section, we present some simulation results with Matlab based on the parameters given in Table 1. The study is aimed at the verification of our theoretical claims on the BER performance of the V-BLAST encoded MIMO WCDMA system under implementation of linear channel equalizers at different SNR values.

The SNR is defined as the ratio of the expected received power at each antenna to the noise power. The channel estimation errors are randomly generated from a Gaussian distribution. Figure.3 illustrates bit error rates (BERs) for various SNRs with Tx = 4, Rx = 4 using QPSK modulation. This figure shows the proposed algorithms have better performance but MMSE with SIC, SIC+MMSE,SIC+ZF algorithm gives far better results when channel estimation errors exist than ML. In Figure.3, we can see the performance improvement more clearly in high SNR. This is because the effect of channel estimation error becomes more dominant as the SNR increases. Figure.4 shows BER performance with Tx = 4, Rx = 4. In Figure.4, the performance improvement is more apparent. As the SNR increases, the interference caused by channel estimation errors becomes dominant and the interference plus noise level becomes nearly constant. The conventional MMSE with SIC algorithm only considers the noise power and ignores the interference when generating the nulling weight. Also see from the table-2 and table-3 result for ZF+SIC and MMSE+SIC is very close to maximum likelihood.

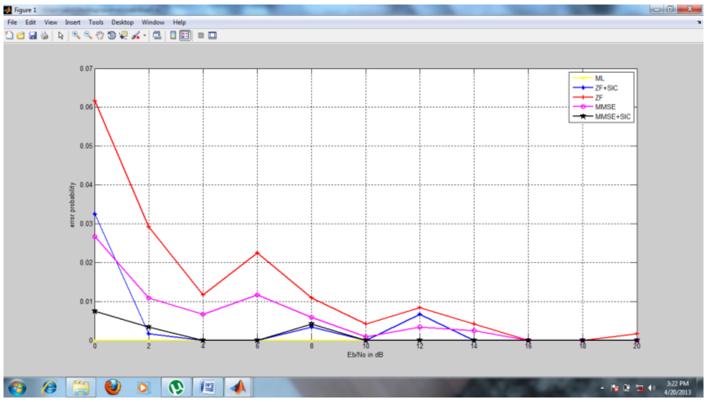

Figure 3.Shows No of errors with increasing SNR.

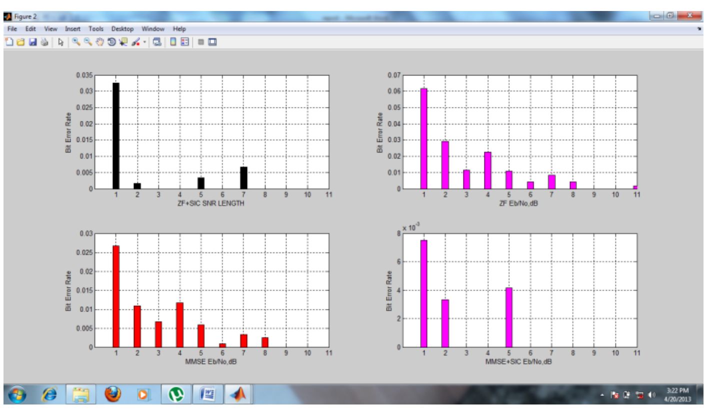

Figure 4. Shows bit error rate with different SNR.

For our best analysis purpose, we deactivate ML related functions of the running matlab program and only considering estimation error performance of other detection algorithms. In Figure 1 and Figure 2, we can clearly demonstrate the Interference suppression from ZF and MMSE in more clear way. In a similar manner, we carry out the BER performance results for QPSK modulation. Figure. 3 illustrates bit error rates (BERs) for various SNRs with Tx = 4, Rx =4. This figure shows the proposed algorithms have better performance but MMSE with SIC EEC algorithm gives far better results when channel estimation errors exist than ML

	NUMBER OF ERROR				
SNR(dB)	**ML**	**ZF+SIC**	**ZF**	**MMSE**	**MMSE+SIC**
1	0	39	74	32	9
2	0	2	35	13	4
4	0	0	14	8	0
6	0	0	27	14	0
8	0	4	13	7	5
10	0	0	5	1	0
12	0	0	10	4	0
14	0	0	5	3	0
16	0	0	0	1	0
18	0	0	0	0	0
20	0	0	2	0	0

Table-2. Number of error with the increasing SNR

We can see from the above table we have number of error at different SNR for the all ML, ZF+SIC, ZF, MMSE and MMSE+SIC. When we analyze the result with the SNR=8 the technique ZF+SIC and MMSE+SIC have less number of error as compare to zero forcing and minimum mean square error technique. With the increase in the value of (SNR=14) the value for both these EEC technique have number of error zero which is equal to the maximum likelihood.

	BIT ERROR RATE (dB)				
SNR	**ML**	**ZF+SIC**	**ZF**	**MMSE**	**MMSE+SIC**
0	0	0.0325	0.0617	0.0267	0.0075
2	0	0.0017	0.0292	0.0108	0.0033
4	0	0	0.0117	0.0067	0
6	0	0	0.0225	0.0117	0
8	0	0.0033	0.0108	0.0058	0.0042

10	0	0	0.0042	0.0008	0
12	0	0.0067	0.0083	0.0033	0
14	0	0	0.0042	0.0025	0
16	0	0	0	0	0
18	0	0	0	0	0
20	0	0	0.0017	0	0

Table-3. Bit error rate value with different SNR

We can see from the above table we have bit error rate at different SNR for the all ML, ZF+SIC, ZF, MMSE and MMSE+SIC. When we analyze the result with the SNR=8 the technique ZF+SIC and MMSE+SIC have less bit error rate as compare to zero forcing and minimum mean square error technique which is required for the system performance. With the increase in the value of (SNR=14) the value for both these EEC technique have less bit error rate value which is close to the maximum likelihood.

1.7. Conclusion & Future Scope

In our present study, we have tried to show performance of a EEC encoded 4 x 4 spatially multiplexed MIMO WCDMA wireless communication system adopting QPSK digital modulation and linear channel equalization schemes., channel equalization (signal detection) and channel coding techniques.

In this paper we proposes the analysis and performance of general MIMO system with Maximum Likelihood (ML), Zero-Forcing (ZF) and Minimum Mean- Square Error (MMSE), Successive Interference Cancellation (SIC) techniques used for linear detectors in fading channels with different antenna selections and QPSK digital modulation method. We concluded that the ZF+SIC and MMSE+SIC achieved the lowest bit error rate when there are some increment in the number of antenna or we can say with the increasing in number of antenna performance of ZF and MMSE with the SIC is equal to the ML.

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