IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

MULTIUSER SYSTEM PERFORMANCE COMPARISON WITH VARIOUS DIVERSITIES USING TURBO DECODING IN LTE+ SYSTEM ENVIRONMENT

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Abstract: A study and researches on the LTE+ wireless network was conducted with the goal of addressing a number of significant technological criteria and issues. Fast time variable coefficients of fading are difficult to properly measure, monitor, and forecast. A multiuser system is a network that has more bandwidth and uses less energy. The benefits of such systems can be experienced while maintaining CSI precision. In multiuser systems, CSI inaccuracies is induced by losses during channel estimation and channel ageing. The influence of change in multiuser diversity and type of data coding on the system throughput and BER using turbo decoding procedures is highlighted in this work. Finally, it is concluded that in performance comparison of transmit diversity and receive diversity in the case of turbo coding, receive diversity shows a 62 percent improvement.

***Index Terms* – Transmit diversity, receive diversity, turbo decoding.**

1. INTRODUCTION:

In digital communication systems, channel coding is frequently employed to protect digital information from noise and interference while also reducing the amount of bit mistakes. These extra bits introduced during the channel coding will allow bit mistakes in the received data stream to be detected and corrected, resulting in more accurate information delivery. The cost of encrypting data via channel coding is a decrease in data rate or an increase in bandwidth.

1.1 BLOCK CODES VS CONVOLUTIONAL CODES

Block codes and convolutional codes are the two basic forms of channel codes. Block codes are based on abstract algebra and finite field arithmetic. They are capable of detecting and correcting faults. Hamming codes, Golay codes, BCH codes, and Reed Solomon codes are some of the most regularly used block codes (uses nonbinary symbols).

Convolutional codes are generally utilized for real-time error correction and are constructed with a separate strong mathematical structure. The Viterbi algorithm is the most used decoding approach for convolutional codes. Many advancements have been made to extend and improve convolutional codes as a result of their widespread popularity.

Trellis coded modulation (TCM) and turbo codes are two new coding systems as a result of this innovation. By merging coding and modulation into a single process, TCM enhances redundancy. TCM has the distinct advantage of requiring no data rate decrease or capacity increase, as most other coding methods do. Recently introduced Turbo code, which is said to be a near-channel capacity error-correcting code. It can send data over a channel with an arbitrary low bit error rate (approaching to the value of zero). This code is obtained by applying the concurrent concatenation of two convolutional component codes separated by a random interleaver. Turbo codes can be decoded using one of two ways. A maximum a posteriori (MAP) algorithm and even a soft output Viterbi technique are used to create them (SOVA). The turbo code decoder needs two (same algorithm) constituent decoders to operate in an iteration process, regardless of which method is used. When these decodings will be performed in different multiuser environments, they will provide the varied system performances in terms of SNR, BER and number of epochs required along with the system complexity. The next section is describing the concept and need of of multiuser environment in communication system developments.

1.2 MULTI USER ENVIRONMENT:

Multiuser diversity relies on the fact that some individuals can have better channels than everyone else at any given point in time in a system with numerous users whose connections fade independently. System resources are distributed to the users who can best use them by broadcasting only to users with the best channels at any particular time, resulting in increased throughput and/or performance. So these techniques results in increased throughput and reduced errors both in uplink and downlink channels.
A point-to-point connection in a single-user diversity system consists of many independent channels where signals can be merged to boost performance. In multiuser diversity the many channels are related to various users, and the system often utilises selection diversity to choose the users with better channel in each particular fading condition.
The multiuser diversity gain is based on users having different channels, therefore the wider the fading's dynamic range, the larger the multiuser diversity gain. Furthermore, performance is improved as the number of individual channels increases, as it does with any diversity strategy. Thus, in systems with a large number of users, multiuser diversity is most successful. This paper focuses on achieving diversity variation based system performance comparison at the transmitter and receiver.
Transmit diversity, receive diversity, spatial multiplexing, and beamforming are the four types of MIMO techniques utilised in LTE. The implementation of receive diversity is primarily the focus of this paper due to the phrase "Multiuser," it has been addressed. The performance of this system is then compared to that of other MIMO techniques. Maximum Ratio Combining (MRC) is used for receive diversity, using either single or multiple antennas on the recipient side (i.e. SISO or SIMO), and STBC is used for transmit diversity.

2. DEVELOPMENT OF THE PROPOSED SYSTEM:

Requirements for the system design and implementation were created based on a complete examination of system parameters and system environment.

2.1 TRANSMITTER SPECIFICATIONS:

BPSK, QPSK, and m-QAM are the modulation methods defined for the implementation phase. Symbol mapping of the input dataset is accomplished using these approaches. After convolutional encoding, the mapped symbols are placed on the fading channels.

2.2 CHANNEL SPECIFICATIONS:

It is taken into account the conventional AWGN channel with consistent noise. The performance degrading channel i..e. Rayleigh's channel is also taken into account.

2.3 RECEIVER SPECIFICATIONS:

When erroneous data is received at the recipient, an iterative procedure is used to approximate and equalise the symbols' output, resulting in optimal system performance. The decision directed channel estimation relying on DDCE+IPVSSNLMS, i.e. updated estimation algorithm, is applied to the corrupted data. The closer the approximations are to the actual symbols, the better.
Equalization is performed on the approximated data using a mixed equalization method based on evolutionary equalization and turbo equalization. Equalization based on the optimal path metric is also done in this process. After the data has been equalized, iterative decoding is used to decode the data, with the Viterbi algorithm with soft output being used.
With these specifications, MATLAB programs are used to simulate, test, and check the performance of a single user system.
Finally, using STBC based transmit diversity and Maximal Ratio Combining based receiver diversity, this single user system is mapped to a multiuser system. The overall system flowchart is presented in figure 1. After that, the system performance is compared using a graph plotting of Eb/No Vs BER. Following that, the efficiency of the improvised algorithm is discussed in results and conclusion section.

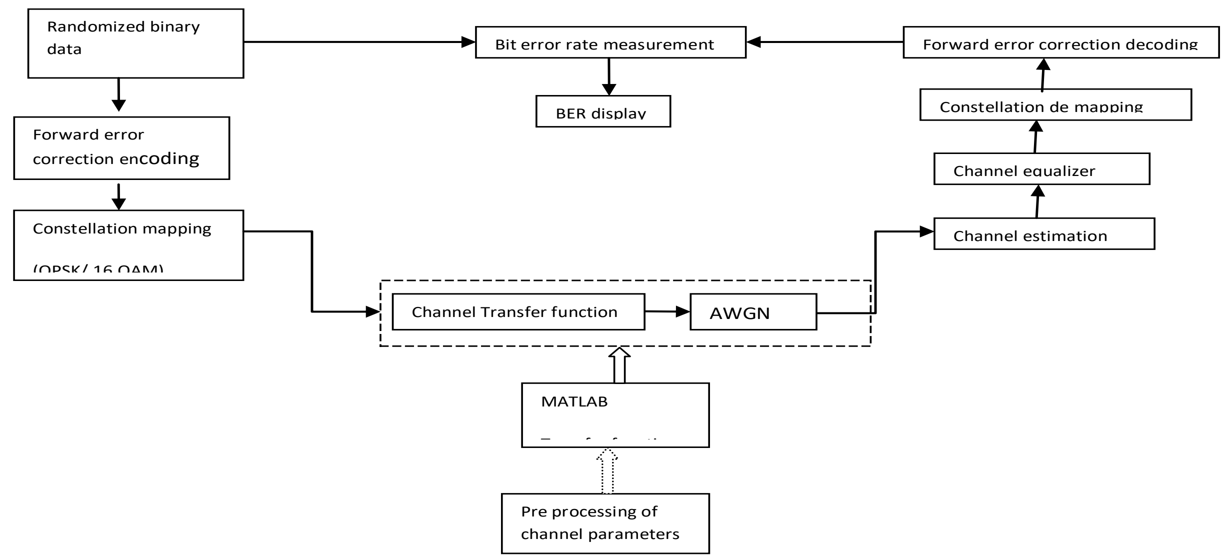

Figure 1: Proposed system flowchart

3. SYSTEM PERFORMANCE CRITERIONS:

Initially the comparison of the system performance is checked by implementing the 2 different turbo decoding algorithms is presented in figure 2. They are namely BCJR and bidirectional SOVA. System parameters used in the system simulation are: Used Frame size = 1024, Turbo decoder algorithms compared: BCJR and Bi-SOVA, Generator polynomial used for coding is D^2+1/ D^2+D+1. When the performance between the 2 Turbo decoding algorithms is compared, it is seen that the bidirectional SOVA method is having slightly better performance as compared to the BCJR algorithm. It achieves the Eb/ N0 value of 3 db with the BER achievable as 10^{-5} which is really appreciable performance.

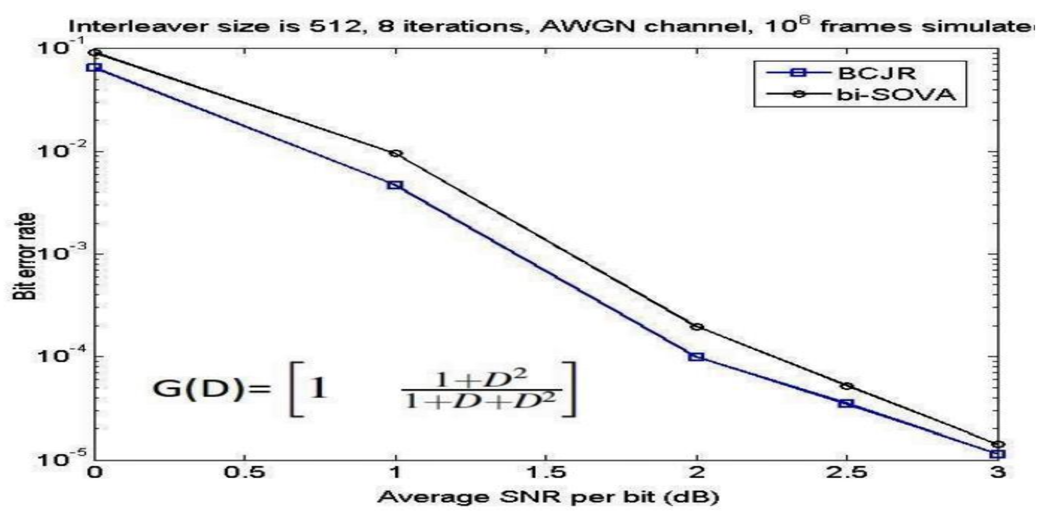

Figure 2: Performance comparison of BCJR Vs Bi SOVA

The repetitive turbo codes obtain the optimum performance with increased number of iterations. It is achieved at 4th to 10th iterations. Also it is observed that the BER was significantly dropped as number of iterations are increased. As required for the optimum performance of the system, BER should be low. And it can be achieved by changing either the size of data packet or the Eb/No. In conclusion, the log MAP algorithm implementation even if complex, performs the best. But the max-log MAP algorithm performs the worst even if it is least complex. Simulations are performed by transmitting Turbo code over the AWGN channel with BPSK modulation.

SNR performance of the bidirectional SOVA decoder is 15% better than the traditional SOVA decoder. For the average SNR value of 3 db, it is achieving the BER near about 10^{-5}. But in the wireless communication system for achieving long distance communication minimum required SNR value should be achieved. And here the need of diversity techniques implementation is raised. Out of the transmit, receive and space diversity, the comparative performance check is carried out with transmit and receive diversity. For this simulation STBC based transmit diversity is considered. While receiver diversity is based on the maximal Ratio Combining. During the simulation, the parameters used were:

Maximum no of error packets considered are 300, Maximum number of packets transmitted are 3000, no. of pilot symbols per frame=8. Here 3 types of diversity based simulations were carried out namely as a)Known channel vs Transmitter diversity comparison (Almouti coding 2*2)(figure 3)

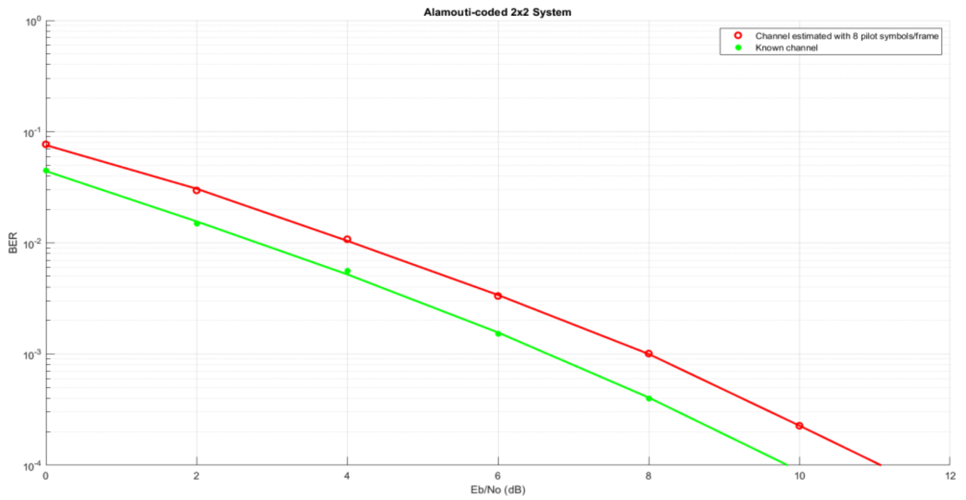

Figure 3 Almouti coded(2*2) multiuser system performance with Transmit diversity

b) Performance comparison of transmit diversity to receive diversity.(figure 4)

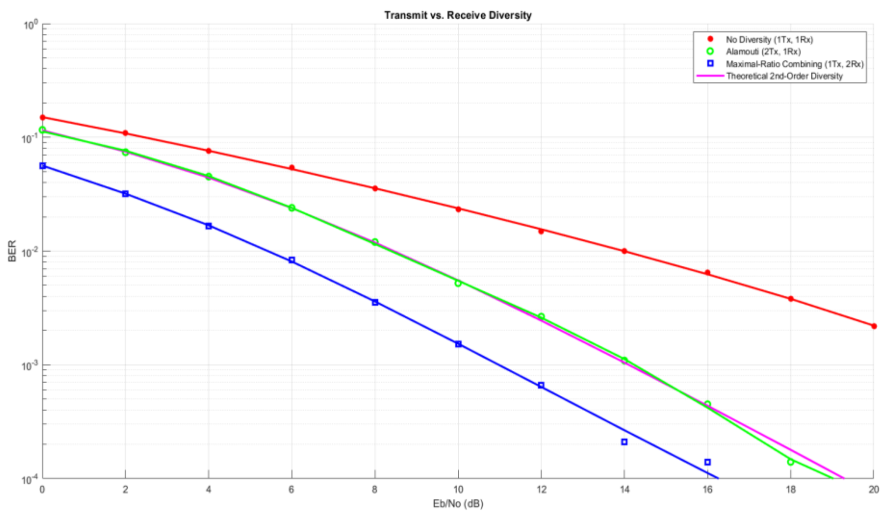

Figure 4: Transmit vs Receive diversity

c) For G4 coded data, comparison of transmit vs receive data is presented. (figure 5)

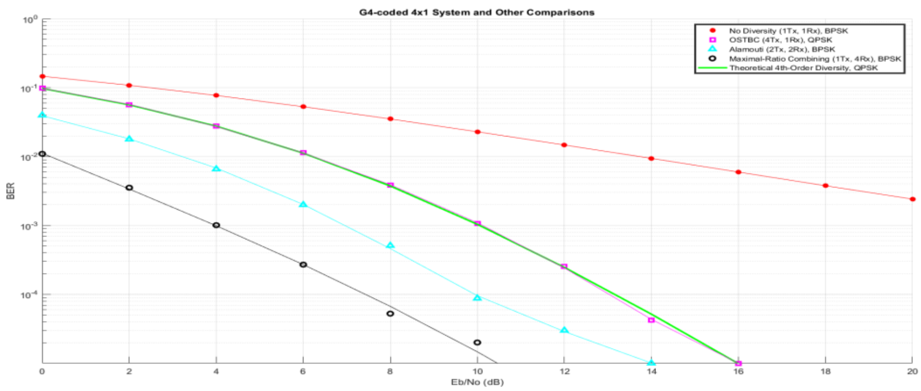

Figure 5: performance comparative of multiuser system

4. Results and Discussion:

Table 1 is created by referring to the figures 4 and 5. This table 1 represents the changes in BER values w.r.t. to .Eb/N0. These changes are noted down for both transmit diversity and receive diversity. For the evaluation of BER vs Eb/N0 plots, the data was encoded with turbo coding and G4 coding. When the transmit diversity is compared against the receive diversity performances, MRC proves to be better as compared to the STBC codes. But when both the diversities are compared with the no diversity performance, it is stated that BER performance of no diversity is worst. At Eb/No of 16db, the achievable BER by receive diversity is of 10^{-4} as compared to same BER is obtained at 19db in case of Transmit diversity in case of Turbo coding. In case of turbo coding the receive diversity shows the improvement by 62% as compared to transmit diversity.

Table 1 variation of BER values w.r.t. Eb/N0 in case of transmit diversity and receive diversity for Turbo coded data and G4 coded data.

Eb/N0	Turbo coded data		G4 coded data	
	Transmit(Almouti) Diversity	Receive(MRC) Diversity	Transmit(Almouti) Diversity	Receive(MRC) Diversity
2	0.08	0.03	0.03	0.003
4	0.06	0.02	0.008	0.001
6	0.05	0.007	0.002	0.0003
8	0.02	0.005	0.0005	0.00005
Improvement	62% improvement in MRC as Compared to Almouti		90% improvement in MRC as compared to Almouti	

5. Conclusion:

This paper focuses on mapping to a multiuser system and analysing the BER values obtained in each of the techniques. When data is delivered by applying turbo coding on the original data and suggested DDCE-IPVSS estimated data, the BER achieved in the case of proposed equalized and estimated data is even lower than when turbo coding is used on the original data without usage of DDCE-IPVSS estimation. Overall, compared to its counterpart, this proposed estimation-based turbo coding will yield a 12 percent improvement. Similarly, the influence of various diversities is mostly examined for transmit Vs receive diversity. Finally, it is stated that when transmit diversity and receive diversity are compared in the case of turbo coding, receive diversity shows a 62 percent improvement.

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