PERFORMANCE EVALUATION OF OFDM WIRELESS COMMUNICATION SYSTEM BASED ON ADVANCED STBC

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Abstract: Orthogonal Frequency Division Multiplexing (OFDM) is come up and auspicious technique for future wireless system for high data rate wireless communication systems over frequency selective channels. Although, OFDM-based systems are sensitive to the inter-carrier interference (ICI) generated by a carrier frequency offset (CFO), it degrades the error probability performance for both single-antenna OFDM systems. Moreover, in a multipath fading environment, performances of OFDM system in a wireless channel are severely degraded by random variations in the amplitude of the received signals as well as by the presence of inter-symbol interference (ISI) and inter-carrier-interference (ICI) which also limit the OFDM system performance. Recently, Alamouti STBC has gained much attention as an effective transmit diversity scheme to provide reliable transmission with high peak data rates to increase the capacity of wireless communication system. In this research work, an advanced method for STBC-OFDM is proposed. The advancements are done with existing method in remapping of complex data after STBC encoding and serial to parallel conversion of complex data. This mitigation actually doubles the length of the data. At the receiver end, again demapping of data is done which halfs the data length. This procedure helps in reduction of chances of error in the signal. The main objective of proposed method is to reduced the BER and SER in STBC-OFDM system. For each simulation, blocks of 1024 symbols are simulated. The proposed system is simulated with two transmitter antennas, two receiver antennas.

Keywords:Space-Time Block Code (STBC), Orthogonal Frequency Division Multiplexing (OFDM), Alamouti code etc.

INTRODUCTION

Wireless communication system plays a vital role in this world. Earlier wireless systems designed to support voice. Nowadays, these are used to transfer the data, they are demanding because of their accessibility and mobility. All wireless technologies face problems of signal fading, multipath, increasing interference and limited spectrum. Orthogonal Frequency Division Multiplexing (OFDM) plays a primitive role and reduces complexity of receiver in wireless broadband systems, synchronization and channel estimation is also very important [8] [16]

MIMO-OFDM system improves wireless performance. For better performance we increase number of transmit antennas and receive antennas [9]. Space -time coding is the combination of coding; modulation and signal processing for achieving transmit diversity. Space-time block coding (STBC) is based on Alamouti transmitter diversity scheme and one of the most efficient coding techniques that can be applied with transmitter diversity systems. Its coding is a technique used in wireless communications to transmit multiple copies of a data stream across a number of antennas. It exploits many of the received versions of data to improve the reliability of data-transfer [10].

Space-Time Block Coding (STBC) with Multiple-Input Multiple-Output (MIMO) set-up was proved to be a productive method for better BER performance [5]. These codes are orthogonal and can achieve full transmission range identified by the number of transmitted antennas [1].The space-time block coding (STBC) technique, is one of the illustrative multiple antenna techniques, also most appealing for these kind of purposes as it easily provides the range at receiver by transmitting a space time coded signal through multiple antennas [4]

Orthogonal Frequency Division Multiplexing (OFDM) has the property of high-speed transmission and robustness to multipath interference [6]. It has become the popular modulation technique in high speed wireless communications [5]. It is more powerful comparative to the other technologies [2]. Indeed of its advantages it has some drawbacks also. The high peak-to-average ratio (PAPR) is the main drawback that causes non-linearity at the receiving end [5].

Orthogonal Frequency Division Multiplexing (OFDM is most encouraging modulation technique that is increasingly being adopted in the telecommunication field [3]. Orthogonal Frequency Division Multiplexing (OFDM) is a Multi-Carrier Modulation technique in which a single high rate data-stream is disintegrated into multiple low rate data-streams and is modulated using sub-carriers that are orthogonal to each other.

OFDM is a Multi-Carrier Transmission Scheme. ODFM is a good explanation for high speed digital communications. In this the data, transmission is separated over a large number of orthogonal carriers, each being modulated at a low rate. The carriers can be made orthogonal by appropriately choosing the frequency spacing among them. But with these benefits there are some issues that OFDM faces:

(i) OFDM signal has very high Peak to Average Power Ratio (PAPR)
(ii) Inter carrier Interference between the subcarriers can cause a big problem in the system.

For any system Bit Error Rate with Signal to Noise Ratio must me improved so that the overall system performance will be enhanced by adopting our Method it can be assure that the system will perform with optimum value [7].

In broad band wireless communications receiver complexity is reduced by OFDM but at same time channel estimation and synchronization are very important so it changed by MIMO-OFDM. MIMO-OFDM is good-looking equipment which generally combines on the same channel by permitting multiple accesses for wireless communication systems like Wireless Local Area Network, MAN, Wi-MAX and 3G-LTE standard in order to lodge many users at the similar time in the similar channel [11]. Multiple-input multiple-output (MIMO) systems combined with orthogonal space time block codes (OSTBCs) and orthogonal frequency division multiplexing (OFDM), known as MIMO-OFDM, are plays an important role in present and future wireless communications [12].

The multipath spread reasons optional time diffusing, settling, and stage change, known as blurring, in the got flag. Code division multiple access (CDMA) structure has the upsides of extending past what many would consider conceivable adjoining the resistance against staying [13]. In frequency selective fading channels, space-time coded OFDM is demanding perspective to provide transmission range and coding gains, which are termed as space-time trellis coded OFDM [10], and space-time block coded OFDM. In particular, the combination of orthogonal space time block codes (OSTBCs) and OFDM, or simply OSTBC-OFDM has drawn much attention because it attains the maximum transmission range and has a simple maximum-likelihood (ML) receiver structure [12-16]. OFDM and MIMO techniques simultaneously allow us to realize and satisfy the ever growing demands of multimedia services and applications. OFDM has already been used successfully in standards for digital audio broadcasting (DAB), terrestrial video broadcasting (DVB-T), and wireless local area networks (WLANs) [14]. Efficient implementation of MIMO-OFDM system is based on the Fast Fourier Transform (FFT) algorithm and MIMO encoding, i.e. Altamonte Space Time Block coding (STBC), the Vertical Bell-Labs layered Space Time Block code V

BLASTSTBC, and Golden Space-Time Trellis Code (Golden STTC) [15].

PROPOSED METHODOLOGY

MATLAB R2013 has been used as an implementation platform for simulating the method. Wireless communication toolbox and generalized toolbox is also used for the implementation. In this research work, an advanced method for STBC-OFDM is proposed. The advancements are done with existing method in remapping of complex data after STBC encoding and serial to parallel conversion of complex data. This mitigation actually doubles the length of the data. At the receiver end, again demapping of data is done which halfs the data length. This procedure helps in reduction of chances of error in the signal. The main objective of proposed method is to reduced the BER and SER in STBC-OFDM system.

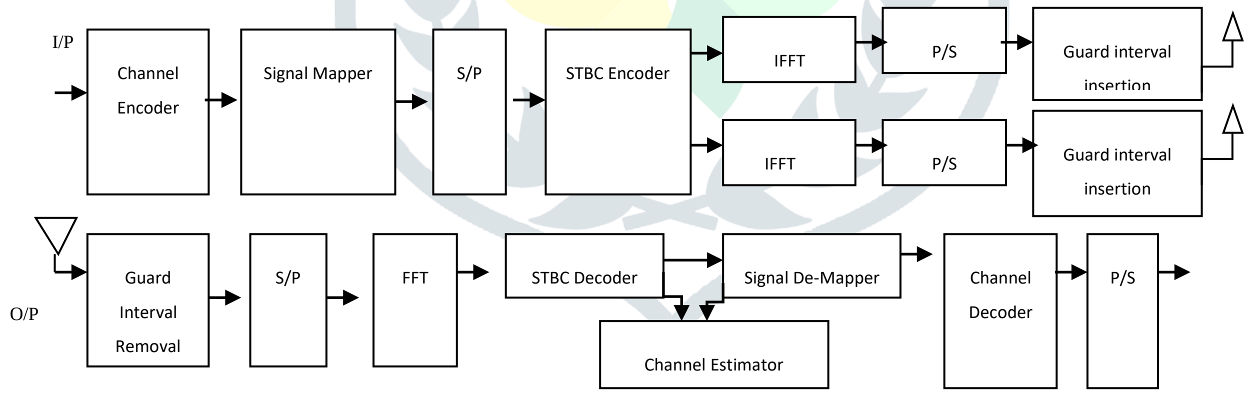

Fig1. Block diagram of STBC-OFDM System

For each simulation, blocks of 1024 symbols are simulated. The proposed system is simulated with two transmitter antennas, two receiver antennas. The channel conditions have two independent paths with path delays in seconds and average path gains = [0 - 20] dB.

The steps of the implementation are given below:

1. Declaration of some input parameters

- Number of transmit antenna
- Number of Receive antenna number receiver
- Number of parallel channel to transmit
- FFT length
- Number of carrier
- Number of number frames
- Number of loops

- Number of information OFDM symbol for per number frames
- Number of time slot
- Modulation type : QPSK/BPSK
- Symbol rate
- Bit rate per carrier
- Length of guard interval

2. Declaration of an outer loop according to number of loops
3. Declaration of an inner loop according to number of frames
4. Declaration of an inner loop according to different values of input SNR
5. Declaration of some counters

- Number of error bit
- Ratio of error bit
- Total number of error signal

6. Designing of transmitter

- Generation of Data according to Number of parallel channel, Number of time slot and Modulation type i.e. QPSK
- QPSK modulation of generated data
- Conversion of data into signal to be sent through Number of parallel channel in both time slot
- Conversion (Encoding) of signal into STBC
- Serial to parallel conversion of STBC signal
- Remapping of data to double the length of it
- Application of IFFT on STBC signal
- Insertion of Guard interval into signal
- Parallel to serial conversion of updated signal
- Application and Calculation of Attenuation by computing Signal power (S_{pow}) and attenuation (α) constant for main data signal

$$\alpha = \sqrt{\frac{\text{Spow}}{2\,.\text{Mqpsk}.10\text{^}\frac{\text{Eb}}{\text{No}}/10}} \qquad (1)$$

Where
S_{pow} is signal power
M_{QPSK} is modulation constant for QPSK
Eb/No is input SNR in dB

$$S_{pow} = \frac{\sum (X1)^2 + (X2)\text{^}2}{\text{NTx.NTs.LFFT}} \qquad (2)$$

Where
X_1 is 1st data stream
X_2 is 2nd data stream
N_{Tx} is No. of transmitter
N_{Ts} is No. of time slots
L_{FFT} is updated length of FFT

- Preparation of two noise streams for main data stream i.e. N_1 and N_2

$$N_1 = \alpha\,(R_{1,LFFT} + i\,R_{1,LFFT}) \qquad (3)$$

Where
α= attenuation constant for 1st reference noise
$R_{1,LFFT}$ = (1* L_{FFT}) matrix of normally distributed pseudorandom numbers
L_{FFT} is Updated length of FET (including guard length)
$N_2 = \alpha\,(R_{2,LFFT} + i\,R_{2,LFFT})$
Where
α= attenuation constant for 1st reference noise
$R_{2,LFFT}$ = (1* L_{FFT}) matrix of normally distributed pseudorandom numbers
L_{FFT} is Updated length of FET (including guard length)

- Application and Calculation of Attenuation by computing Signal power ($S_{pow\ ref}$) and attenuation constant (α_{ref}) for Reference data signal

$$\alpha_{ref} = \sqrt{\frac{\text{Spowref}}{2\,.\text{Mqpsk}.10\text{^}\frac{\text{Eb}}{\text{No}}/10}}$$

Where
S_{powref} is signal power of reference data stream
M_{QPSK} is modulation constant for QPSK
Eb/No is input SNR in dB

$$S_{powref} = \frac{\sum(Xref1)^2+(Xref2)^\wedge 2}{NTx.NTs.LFFT} \quad (4)$$

Where,
X_{ref1} is 1st Ref. data stream
X_{ref2} is 2nd Ref. data stream
N_{Tx} is No. of transmitter
N_{Ts} is No. of time slots
L_{FFT} is updated length of FFT

- Preparation of two noise streams for reference data stream i.e. N_{ref1} and N_{ref1}

$$N_{ref1} = \alpha_{ref1} (R_{1,LFFT} + i R_{1,LFFT})$$

Where
α_{ref1} = attenuation constant for 1st reference noise
$R_{1,LFfT}$ = (1* L_{FfT}) matrix of normally distributed pseudorandom numbers
L_{FFT} is Updated length of FFT (including guard length)

$$N_{ref2} = \alpha_{ref2} (R_{1,LFFT} + i R_{1,LFFT})$$

Where
α_{ref2} = attenuation constant for 2nd reference noise
$R_{1,LFFT}$ = (1* L_{FFT}) matrix of normally distributed pseudorandom numbers
L_{FFT} is Updated length of FFT (including guard length)

- Preparation of 2 channel matrices H_1 and H_2 for data signal

FIRST CHANNEL MATRIX H_1

$$H_1 = \frac{10^\wedge(-\frac{Pdiff}{10})}{\sqrt{\sum(10^\wedge(-\frac{Pdiff}{10})^\wedge 2}} \quad (5)$$

Where, P_{diff} = path difference (20dB)

$$H_2 = \frac{10^\wedge(-\frac{Pdiff}{10})}{\sqrt{\sum(10^\wedge(-\frac{Pdiff}{10})^\wedge 2}}$$

SECOND CHANNEL MATRIX H_2
Where, P_{diff} = path difference (20dB)

7. Designing of Receiver

- Breaking of received signal into two parts
- Mounting of signal on to the channel and addition of Noise to the signal
- Serial to Parallel conversion of data
- Removal of Guard interval from signal
- Application of FFT on signal
- Decoding of STBC signal
- QPSK demodulation of decoded signal
- Computation of Symbol Error Rate (SER)

$$SER = \sum (X_{TX} - Y_{RX}) / N_{CH} / N_{SYM}$$

Where, X_{TX} is Source Data at transmitter
Y_{RX} is data at receiver
N_{CH} is Number of channels
N_{SYM} is Number of symbols

- Computation of Bit Error Rate (BER)

$$BER = \sum (X_{TX} - Y_{RX}) / N_{CH} / N_{SYM} / N_{Frame}$$

where, X_{TX} is Source Data at transmitter
Y_{RX} is data at receiver
N_{CH} is Number of channels
N_{SYM} is Number of symbols
N_{Frame} is number of frame

- Display of SER and BER

EXPERIMENTAL RESULTS

This section gives the characteristic information about the performance evaluation of proposed approach. Simulations are done in MATLAB R2013a using the Rayleigh multipath fading channel model. In this research work, an advanced method for STBC-OFDM is proposed. The advancements are done with existing method in remapping of complex data after STBC encoding and serial to parallel conversion of complex data. This mitigation actually doubles the length of the data. At the receiver end, again demapping of data is done which halfs the data length. This procedure helps in reduction of chances of error in the signal. The main aim of proposed method is to reduced the BER and SER in STBC-OFDM system. For each simulation, blocks of 1024 symbols are simulated. The proposed system is simulated with two transmitter antennas, two receiver antennas. We have used channel conditions, which have two independent paths with path delays in seconds and average path gains = [0 - 20] dB. The order of the modulation imposes the number of the diverse symbols that can be transmitted in a digital communication system. There are various modulation schemes like PSK, FSK and AM. In this work, the proposed approach was tested over various PSK modulations like, BPSK, QPSK, 16-PSK and 32-PSK over Rayleigh fading channel. The performance of the proposed method is compared with that of existing STBC-OFDM system using BER and SER. To keep the comparison level same, we have kept all the input parameters almost same. The list of the used parameters is given below in table no. 1

Table 1: List of input parameters

S. No.	Parameter Name	Value
1.	Number of transmitters	2
2.	Number of receivers	2
3.	Number of channels	512
4.	Length of FFT	1024
5.	Number of carriers	512
6.	Number of Frames	10
7.	Number of Loops	10
8.	Number of Symbols	4
9.	Number of slots	2
10.	Symbol rate	250000
11.	Guard Interval Length	128
12.	Noise	AWGN
13.	System Model	MIMO

The performance of proposed approach is given in snapshot below. BER and SER wrt input SNR are calculated and shown below. Figure 1 is the snapshot of SER vs. input SNR of proposed work. Figure 2 is the snapshot of BER vs. input SNR of proposed work. Figure 3 is the snapshot of comparison of BER vs. input SNR of proposed work and existing work. Figure 4 is the snapshot of comparison of SER vs. input SNR of proposed work and existing work. We have also given the values of BER at different input SNR in Table 2.

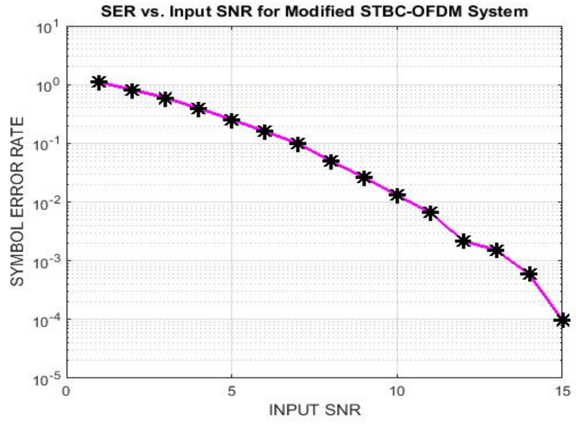

Figure 2: snapshot of SER vs. input SNR of proposed work

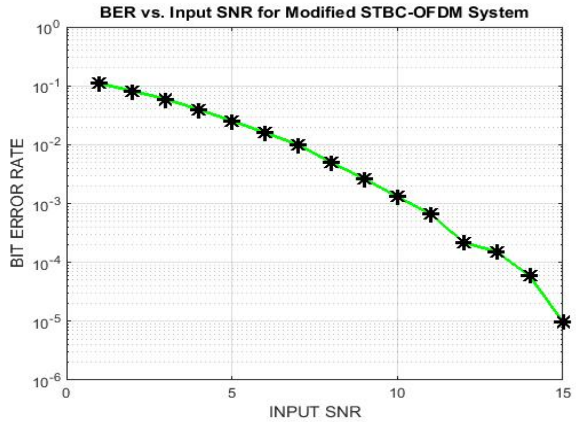

Figure 3: snapshot of BER vs. input SNR of proposed work

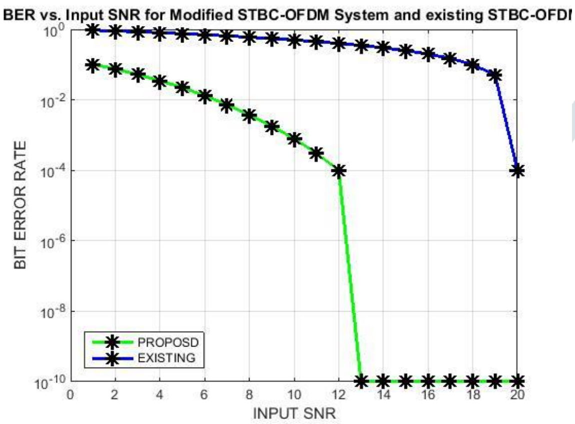

Figure4: snapshot of comparison of BER vs. input SNR of proposed work and existing work

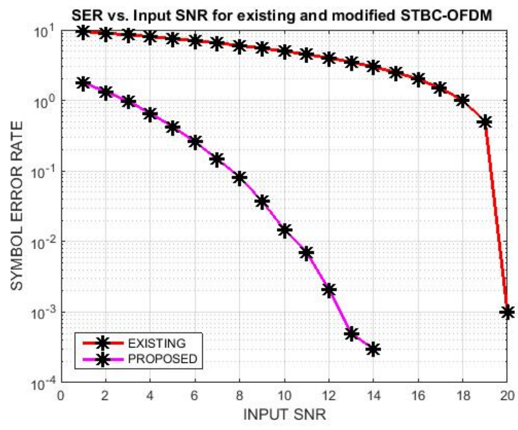

Figure5: snapshot of comparison of SER vs. input SNR of proposed work and existing work

Table 2: Comparison between existing and proposed STBC-OFDM sytem using BER

Input SNR in dB	BER for existing STBC-OFDM	BER for proposed STBC-OFDM
1	0.9501	0.1018
2	0.9001	0.0754
3	0.8501	0.0523
4	0.8001	0.0348
5	0.7501	0.0222
6	0.7001	0.0132
7	0.6501	0.0073
8	0.6001	0.0037
9	0.5501	0.0018
10	0.5001	0.0008
11	0.4501	0.0003
12	0.4001	0.0001
13	0.3501	0.0000000001
14	0.3001	0.0000000001
15	0.2501	0.0000000001
16	0.2001	0.0000000001
17	0.1501	0.0000000001
18	0.1001	0.0000000001
19	0.0501	0.0000000001
20	0.0001	0.0000000001

CONCLUSION

An advanced MIMO-STBC-OFDM system has been dispensed in this research work. Simulation results preferred that the performance of the advanced STBC-OFDM system is superior or comparable to that of the existing STBC-OFDM according to BER. The proposed advanced STBC-OFDM has the advantages of a lower computational complexity and a higher data rate. The proof of above statements is given in last chapter. It is very clear from there that proposed method is very efficient in terms of BER as compared to that of existing system. The advanced STBC-OFDM focus to offer wireless multimedia service for digital home where high data rate is extremely important. We concluded that the proposed method is suitable for real-time multimedia service in the general wireless digital home environment and can be applied to the intenselyunfavorable channel environment.

REFERENCES

[1] Deshmukh, A., & Kokate, M. D. (2015).Comparison of BER for Different Scheme in STBC-OFDM Receiver.International Journal of Modern Trends in Engineering and Research, 2(7): 1518-1524.

[2] Gandha, M., Sisodiya, V., & K N Pawar (2015).A Review on Channel Estimation Methods in MIMO-OFDM. Global Journal of Advanced Engineering Technologies4, 431-435.

[3] Manik, Gunjan, Alka Kalra, and Sanjeev Kalra (2012). Performance Analysis of STBC-OFDM System under Multipath Fading Channel. International Journal of Soft Computing and Engineering, PP. 87-90.

[4] Jung, & Ho-Chul (2000). A Comparative Performance Analysis of STBC-OFDM Systems under Rayleigh Fading Environments. Daeduck science town, Republik of Korea: Hankuk Aviation University.

[5] Maurya, Gaurav and Pramod Patel (2014). An Extensive Review on STBC for MIMO OFDM System. International Journal of Emerging Technology and Advanced Engineering, 4(8): 352-357.

[6] V. Sudha Rani and B.L Malleswari (2012). A Review: OFDM with Diversity Techniques in Wireless Communication MPGI National Multi Conference, Advancement in Electronics &Telecommunication Engineering International Journal of Computer Applications, 7(8),36-38.

[7] Pandey, M., &Tripathi, B. (2014). Review on STBC coded MISO and MIMO in Frequency Selective Wireless Fading Channel. International Journal of Computer Applications (0975 – 8887).

[8] Rao, V., & Malavika, T., (2014). Performance analysis of MIMO-OFDM for multiple antennas. Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering.

[9] Suryavanshi, P., Thakur, S., &K. K. Nayak (2015), Performance Analysis of MIMO-OFDM and MISO- OFDM System based on STBC Code International Journal of Computer Applications.

[10]Aggarwal, A., &Bindia. Performance Evaluation of Advanced STBC MIMO Wireless Communication System with Channel Estimation Based Block Coding. 3(2)

[11] Srinivasulu, O., & Kumar, R., (2017). Performance Analysis of STBC MIMO -OFDM based WI-MAX for Various Equalizers to Reduce BER. 12(3)

[12] Daksh, J., Mohan, R., & Sharma, S., (2013). Result discussion with in MIMO-OFDM Systems with Multiple Antennas. International Journal of Advanced Computer Research.

[13] Choubey, R., & Reddy, V. Channel estimation in space time block coded MIMO–OFDM system: A review. International Journal of Advanced Technology and Engineering Exploration. 5(38).

[14] Haque, Md., Rahman, Md., & Ki-Doo Kim, (2013). Performance Analysis of MIMO-OFDM for 4G Wireless Systems under Rayleigh Fading Channel. International Journal of Multimedia an Ubiquitous Engineering.

[15] Harshala. N. Pundkar, & Aishwarya. P. Kogekar, (2015), Analysis of MIMO-OFDM System with Transmission, International Journal of Advanced Research in Electrical Electronics and Instrumentation Engineering. 4(10)

[16]Alam, M. M., Islam, A. T., & Ullah, S. E. (2011). Performance Analysis of a Concatenated LDPC Coded Alamouti-Based STBC-OFDM System on Text Message Transmission, International Journal of Computer Science, Engineering and Applications (IJCSEA) 1-9.