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A Combined Coded Scheme for OFDM System for Achieving Improved Received Signal

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Abstract— *Transmission in OFDM system is carried out using different encoding schemes and channel equalization techniques so that errors in sub-carriers can be removed to accomplish efficient communication. To this end, significant numbers of authors have developed various techniques. One of the techniques giving efficient results utilized Low-Density Parity Check Code (LDPC) coding technique the e but this technique can give enhanced results. In this thesis, a novel model is developed. The system is proposed by utilizing space-time trellis code (STTC) for encoding and decoding the signal. This approach is helpful in diminishing the bit error rate. Along with this, noise in the channels is also removed by introducing ML equalizer. Three different types of channels are used for evaluating the system. The channels utilized are AWGN, Rayleigh and Rician. Simulation is performed by using MATLAB. Comparative analysis is performed for three channels and the traditional technique. The results show that proposed system has produced better results and is more efficient than the existing techniques.*

Keywords: STTC, OFDM, AWGN, Rayleigh and Rician

1. INTRODUCTION

Multiplexing is the technique using which multiple signals or bit stream information is sent over the single communication channel with different frequencies for different signals. At the received end, all the signals are separated. This process is called de-multiplexing and device employed for this process are called "De-multiplexer". Multiplexing plays an important role in reducing the bandwidth required for sending the data. Multiplexing is mainly of two types Time-Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM). These are also further divided into different schemes. OFDM is the multiplexing technique of the Frequency Division. It stands for (OFDM) orthogonal field division Multiplexing. It transmits big quantities of information across the radio wave. It breaks the reduced stream bit rate of high-rate DataStream, which is then sent over subcarriers. As the duration of the symbol increases for low-rate parallel subcarriers, the relative value of the time dispersion due to the spread of multipath delay is reduced [1] [2].

OFDM is the mechanism of the digital signal modulation where single data stream is broken into various different narrowband channels having different frequencies for reducing the crosstalk and interference. OFDM also serves as the alternative for mobile communications by facilitating the multipath effects. Reception of the signals in build areas having delayed spread of few microseconds, channel becomes highly frequency selective nature and in such conditions complex equalization schemes are needed for the transmission of high bit-rate. But combination of OFDM and coding along with interleaving in COFDM can get benefit from the variations associated in the multipath [3].

Orthogonality permits the carriers to be different from each other at the receiver end. Sub-carriers are selected in such a way so that sidebands of respective carriers may overlap unless there is no crosstalk at the sub-channels of critical frequency of sub-carrier. Using the IFFT i.e. Inverse Fast Fourier Transform, sub-carriers' spacing is [4] selected so that the frequency where the received signal is evaluated, all signals becomes zero. Orthogonality exits between subcarriers which makes the system robust against the ISI effects by CP. Each subcarrier in OFDM system contains high side-lobe power. Hence channel capacity is reduced in OFDM. These drawbacks become problems in case of mobile applications [5], [6].

The errors produced during signal transmission are reduced by applying various techniques. LDPC is the commonly used technique. There are various error correcting techniques which are opted by the researchers. Additive-White Gaussian Noise (AWGN) is the channel used in previous techniques. This paper introduced Rician and Rayleigh fading channels to estimate the bit error rate. This paper is divided into different sections which present literature review, STTC encoding technique and proposed work along with the results.

2. RELATED WORK

Many researchers have developed different number of techniques to reduce the bit error rate while transmitting data from one end to another. OFDM is widely used the researchers to compare the relation of signal to noise ratio (SNR) and Bit error rate (BER).

Ramzan and M. O. B. Saeed, (2018) [7]: proposed a model in which LDPC was used for decoding the received signal to achieve the original bits. From the results of the system, it was found that the OFDM system coded with LDPC performs

well as compared to system which was not coded as per the BER v/s Eb/No in decibels.

Goel and M. K. Garg,(2012) [8] in this paper convolution and LDPC encoding schemes had been used for enhancing the OFDM performance. Bit error rate performance of the convolution supported coding and LDPC encoded OFDM were tested for various code rates in AWGN and fading channel. OFDM performance was compared with the proposed coded OFDM.

S. Shu, et.al, (2015) [9] proposed the LDPC encoding scheme known as invertible subset LDPC for reducing the complexity and PAPR. In the present paper, ISLDPC was used in OFDM-WLAN systems and also developed the systems which fulfill the needs of IEEE 802.11 OFDM systems. Also interleaved subset mapping technique has been proposed for ensuring the diversity gain. From the simulation results of the IS-LDPC coding for OFDM-WLAN system it was discovered that the proposed system shown better error correcting performance and also suppressed the PAPR. From the results it was ensured that this proposed scheme could work as an effective PAPR reduction scheme for the IEEE 802.11 OFDM-WLAN system.

A. Farzamnia, et.al, (2017) [10]*:* Author used the OFDM pilot dependent channel estimation in the present paper. Channel tracking and estimation scheme was connected at the receiver end. Channel estimation scheme was necessary for channel state information for decoding the data. Author took the least square mechanism for sparse channels. Coefficients for the channel were approximated by implementation of the mechanism and MMSE mechanism. From the results of the proposed system it was concluded that the MMSE scheme outperformed t he LD method. It was discovered that LS provides less BER for sparse channel as compared to the general LS mechanism.

C. Chen, et.al, (2010) [11]: in this paper author had used the new CRC dependent error correction technique which used the frame padding for sustaining the enough amount of information as compared to the traditional FCS scheme. Here concept was to attain the significant enhancement in detection and correction of error on the 1st retransmission i.e. second transmission. From the mathematical analysis author showed the significant improvement in the proposed system.

2.1 SPACE TIME TRELLIS CODE

By applying several broadcast antennas the model of STTCs is projected by the V. Tarokh, H. Jafarkhani, and A. R. in the year of 1998 [12]. In conjunction with the STTCs can offer considerable coding gain, spectral effectiveness and diversity advancement. As among the enhancement in the numbers of the antennas and the size of the modulation there is an exponential growth in the decoding complexity group is a key demerit. Therefore generally it cannot be utilized for enlarged constellations. Concurrently, the Space-Time Trellis Codes can offer coding gain, spectral effectiveness, and diversity enhancement on flat fading channels.

3. PROPOSED WORK

As in the existing technique there is a problem of bit error rate in the system. Existing techniques are not efficient enough in reducing bit error rate which may lead the system inefficient. Due to which there is need to introduce the concept of controlling the ber or channel effect to remove data error as well as to minimize bit error rate in the system. Thus to this end, a technique is proposed which uses STTC code for diminishing the error generation in the system. As an improvement the channel equalization approach will be introduced so that the effect of channel can be controlled and less variation will be there in the system that will improve the BER of the overall system. As the channel equalization will be introduced in the proposed model the model will also be analyzed over different channels as AWGN, Racian and Rayleigh Fading Channel.

The methodology opted by the proposed work is shown in the following figure.

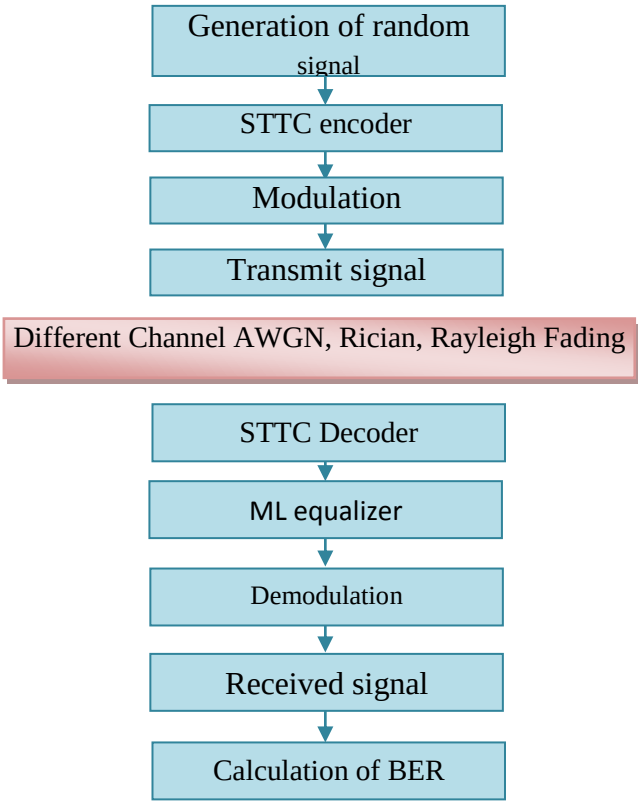

Figure 1: Framework of proposed work.

4. RESULTS AND DISCUSSION

This section discusses about the simulation of the proposed work to correct the loss of sub carriers in OFDM system. In order to reduce the error generation in the system, space-

time trellis codes (STTCs) is implemented and the noise in the channels is removed by applying Maximum Likehood (ML) estimation technique. The results of the proposed work are analyzed to checks its efficiency. For the evaluation, MATLAB software is used and the model is tested for three different types of channels, namely, AWGN, Rayleigh and Rician. The results are attains in terms of bit error rate for each channel. Following is the details of the channels utilized in the novel work for its assessment.

Bit Error Rate (BER):

Bit error Rate (BER) is the most fundamental measure of system performance. That is, it is a measure of how well bits are transferred end-to-end. Although factors like signal to noise and distortion affect this performance, the quality of the connection ultimately is defined by the capability of obtaining the information without any kind of errors.

BER is the number of bits received in error, divided by the total number of bits received.

$$BER = \frac{number\ of\ recieved\ bits\ in\ error}{total\ number\ off\ sent\ bits}$$

Comparative analysis with existing technique

This section gives the comparative analysis of proposed work with the existing LDPC technique in OFDM channel. Three different graphs are shown for AWGN, Rayleigh and Rician channels which are compared with the LDPC based OFDM channel.

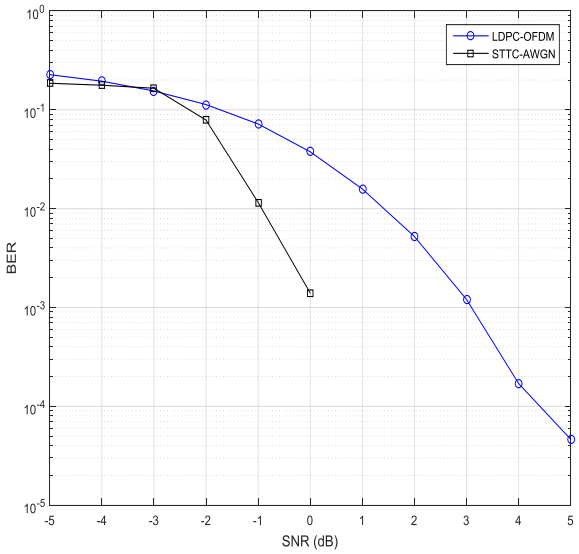

Figure 2: Comparison of STTC AWGN and LPDC-OFDM in terms of BER

The graph obtained for the comparison of AWGN based on STTC with LDPC based OFDM is exemplified in figure 2. The graph clearly shows that the proposed model gives very low bit error rate. For certain SNR, both the mode generate same bit error rate. It can be seen that the errors are not generated when SNR becomes in proposed model however, in conventional method, BER is produced until the power is increased. This validates the efficacy of projected model. STTC is more efficient than LDPC.

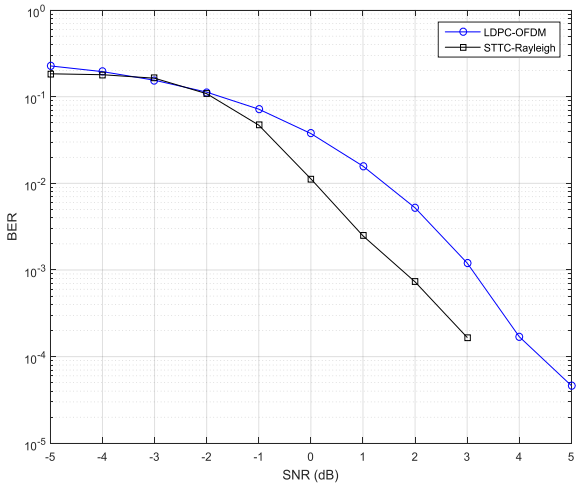

Figure 3: Comparison of STTC Rayleigh and LPDC-OFDM in terms of BER

The results of STTC-Rayleigh when compared with the traditional approach, the graph is obtained and displayed in figure 3. In the beginning, both the models produced same bit error rate, but BER for these models changes when SNR is -3 dB. The bit error rate for proposed method is less than that of tradition LDPC based system. The error in the proposed system remains until the signal to noise ratio is 3dB.

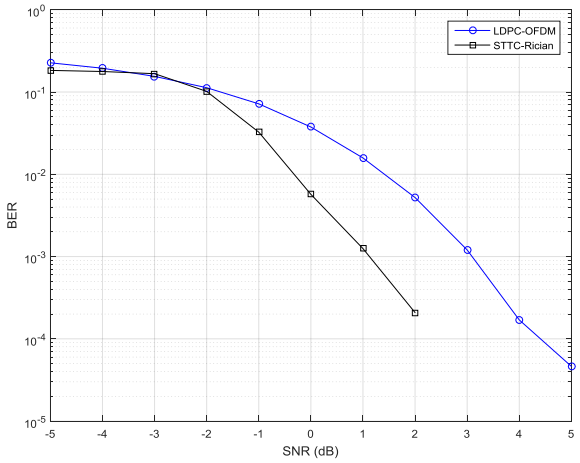

Figure 4: Comparison of STTC Rician and LPDC-OFDM

The graph in figure 4 compares the STTC based rician channel with conventional LDPC based OFDM system. The bits received in error in the proposed model are less as compared to that of existing LDPC technique based OFDM. The proposed model is observed to be more efficient.

Comparison of proposed work's channels

Eventually, the comparison between the channels utilized in the proposed technique is performed. The results acquired after comparison are presented in a graphical view which is shown in figure 5. AWGN, Rician and Rayleigh channels are efficient than existing technique (explained in above section). However, from these three channels based on STTC, Rayleigh is countered to be more efficient as the BER produced in this channel constituted to 10^{-4} approximately. Further, the BER in Rician is slightly less than that of Rayleigh fading channel. The proposed model based on STTC gives better results for the three channels than existing technique in OFDM system. The results ensured the supremacy of the developed model to reduce the error generation during transmitting the data from sender to receiver.

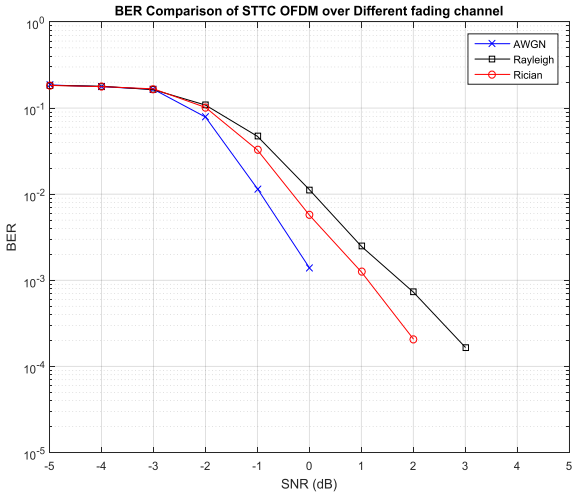

Figure 5: Comparison of proposed model in terms of AWGN, Rician and Rayleigh

Table 1.Comparison between LDPC-OFDM and STTC-AWGN

SNR (dB)	LDPC-OFDM	STTC-AWGN
-5	0.2265	0.1856
-4	0.1947	0.1771
-3	0.1549	0.1652
-2	0.1129	0.0787
-1	0.0718	0.0116
0	0.0376	0.0014
1	0.0158	0
2	0.0052	0
3	0.0012	0
4	0.0002	0
5	0.0000	0

Table 2.Comparison between LDPC-OFDM and STTC-Rician

SNR (dB)	BER in LDPC-OFDM	BER in STTC-Rician
-5	0.2265	0.1832
-4	0.1947	0.1776
-3	0.1549	0.1671
-2	0.1129	0.1018
-1	0.0718	0.0325
0	0.0376	0.0057
1	0.0158	0.0013
2	0.0052	0.0002
3	0.0012	0
4	0.0002	0
5	0.0000	0

Table 3.Comparison between LDPC-OFDM and STTC-Rayleigh

SNR (dB)	BER in LDPC-OFDM	BER in STTC-Rayleigh
-5	0.2265	0.1837
-4	0.1947	0.1794
-3	0.1549	0.1635
-2	0.1129	0.1084
-1	0.0718	0.0470
0	0.0376	0.0113
1	0.0158	0.0025
2	0.0052	0.0007
3	0.0012	0.0002
4	0.0002	0
5	0.0000	0

However, from these three channels based on STTC, Rayleigh is considered to be more efficient as the BER. Further, the Bit Error Rate in Rician is slightly minimum than that of Rayleigh fading channel.

5. CONCLUSION

This thesis presents the approach to correct the sub carrier loss so that signal can be received with minimum distortion. The transmission is carried out in the OFDM environment as enormous quantity of signals can be sent to the receiver side. The proposed model used space time trellis code for encoding and decoding of the signal in transmitter and receiver side respectively. The noise in the channels is

reduced by applying maximum likehood equalizer. The model is evaluated for three different channels- AWGN, Rayleigh and Rician. Signal is transmitted through these channels and the performance of the system is evaluated in terms of Bit error rate. Each channel experienced different bit error rate according to signal to noise ratio present in it. The results showed that the STTC based model gives better results than existing LDPC technique. Also, the comparison of the BER produced by the channels in the proposed work show that Rayleigh channel experienced minimum BER and the signal is transmitted with efficacy

6. FUTURE SCOPE

The proposed model is demonstrated as an efficient one; however, there is still a scope of modification in it. As a future scope, the concept of optimization can be introduced for the channel equalization. Also, the system can be extended to the massive MIMO to make its application 5G oriented.

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