RESEARCH ARTICLE OPEN ACCESS

BER ANALYSIS OF DIFFERENT FEC SCHEMES OVER VARIOUS CHANNELS

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ABSTRACT

In this paper we have identified the importance of forward error correction (FEC) codes. In mobile communication applications for reliable communication the basic requirements are higher capacity &data rates. Using forward error correction codlings such as convolution coding, cyclic redundancy coding are used to improve the bit error rate &spectral efficiency of an OFDM system based on AWGN & Rayleigh fading channels. In speech signal transmission we have calculated the performance of OFDM system with different modulation techniques; those are BPSK,QPSK,16-QAMand 64-QAM by using FEC codes. The performance is analysed using mat lab simulation .The simulation has been done by using QPSK modulation techniques when compared with encoded resultant modulation. The performance of the convolution interleaved based OFDM systems is better than that of CRC interleaved OFDM system as well as un-coded OFDM channels.

Keywords:-convolution coding (CC) codes, orthogonal frequency division multiplexing (OFDM),Cyclic redundancy check (CRC).

I.INTRODUCTION

In wireless communication systems OFDM based communication system has been identified as important technique for both fixed and mobile applications. wireless communication systems widely adapted OFDM scheme for its high data rate transmission along with high bandwidth efficiency OFDM is mainly used to handle multipath interference & to reduce ISI causing BER in frequency selective fading environments .OFDM has a number of applications together with digital video broadcasting In coding techniques symbols present in the encoded message is to be increased to provide two objectives at the receiver .they are error detection &error correction .it is important to evaluate the performance of wireless devices by considering the transmission characteristics, wireless channel parameters and device structure. OFDM technique is a multi-carrier transmission technique which is being recognized as an excellent providing wide range of services with high data rate transmission &with variable bit rates up to 2mb/s.Wi-MAX is a wireless technology that provides high throughput over large distances and at very low cost .ISI can be eliminated by adding guard intervals. Channel coding is an important part in OFDM system. By this the work can be done on encoder ,decoder &interleaving design in OFDM over various fading channels. In OFDM ,many error correcting codes can be applied on convolution codes and cyclic codes

Different performance techniques can be applied on SNR,BER to have accurate performance in OFDM channel. Digital Audio Broadcasting (DAB) is mainly used in OFDM as it gives information with high quality .broadcast systems are used to transmit the data between 20-100km.ISI is mainly caused due to multipath &ghosting. the next coming standard 802.16 is mainly error correction method over various wireless communication channels. In OFDM, cyclic prefix is used to decrease ISI. Two main disadvantages of OFDM are BER &high peak to average power used to support up to 500mbps.OFDM is mainly used to have high data rate transmission with forward ratio.

OFDM systems must have high PAPR compared to single carrier systems .different types

of blocking codes namely CRC, convolution etc are analysed using QPSK modulation using various channels such as AWGN, RAYLEIGH etc. The main intension of this paper is to analyse the behaviour of CRC, convolution codes in OFDM and also to compare results with other coded, uncoded results in various wireless communication channels.

II.RELATED WORKS

ZahidHasan concluded in [1] that the performance of the OFDM system in digital color image transmission over AWGN channel is comparatively better as compared with Rayleigh fading channels. And also observed from his simulation that the performance of QPSK modulation technique much more better than BPSK because QPSK is double bandwidth efficiency.

M.K. gupta, illustrates in[2] the way to increase the system through put while maintaining system performance under desired bit error rate. From his simulation it is concluded that it is possible to improve the performance of un coded OFDM can be improved by convolution coding streams.

Md.Golam Rashed ,Harnot kabir[3] they are analyse the performance of interleaved CRC encoded QPSK based wireless communication system are analysed and from their simulation, the inter leaved CRC encoded QPSK based system provides unique performance in proper identification and retrieval of transmitted color image.

Kangkan thakuria , vivekanadha, theair analysis compared to PSK or QAM has a poor error performance. Consequently is seldom used for high performance digital radio systems .the PSK have constant envelop and frequency but discontinuous phase transitions from symbol to symbol.

M.K.Mishra, proposed that average BER expressed in terms of the higher transcendental function such as the confluent hyper geometric functions.

III.FEC CODES

In wireless communication FEC code is called has error control coding and it is widely used as an error controlling tool for data it .It has the ability to detect and correct limited number of errors without needing a reveres channel for retransmitting the data this FEC is mostly suitable for retransmissions which are relatively costly. Mostly we have used CRC convolution coding and block interleaving.

A.CRC CODING:

CRC is specifically designed to protect against common types of errors.CRC can also provide quick ,reasonable assurance It provides define against data corruption in many digital networks it is used to detect sudden changes occur in computer data in these we use CRC polynomials has they provide significantly less error detection capability.

In this CRC method fixed, short length binary number of check bits and it is called as check sum, which is appended to message being limited receiver and determine whether check bits agree with data or not CRC is an important popular error correction coding technique due to

1. Simple to implement in binary hard ware
2. Easy to analyse mathematically
3. Easy to detect common errors etc.,

CRC is specifically designed to protect against common types of errors.CRC can also provide quick, reasonable assurance to transmitted data. They are not suitable for protecting by altering data.so,it is easy for an attacker to edit message and recalculate CER without being detected substitution being detected

B.CONVOLUTION CODING:

It is mainly consists of convolution encoder again this encoder consist of shift register which provides temporary storage shifting operation for input bits. It is also provides exclusive -OR logic circuit which generates codes output from the bits present in shift register. This coding is extensively used in numerous applications in order to achieve reliable data transfer including Digital video, radio, mobiles, satellite[4]common etc.,. In this the operation is equivalent to binary convolution so it is called as convolution coding [5,6].The ratio R=K/N is called code rate for a convolution coding where K-number of parallel input bits,N- is number of parallel decoded output bits M- is symbolized number of shift register. Shift register stores the state information of this encoder.

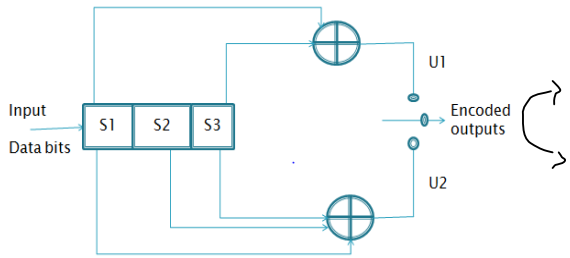

Fig1: Convolution encoder with rate ½,k=1,N=2,M=3,K=4

Because of hostile channel environment, voice coders are designed to work well with BER of 10^-3 and acceptable to above this. This code is highly suitable for AWGN channel[7].on the case of GSM standards for Mobil communication, convolution codes are needed with interleaving to protect against channel errors.

IV.SIMULATION MODEL

The main objective of this work is to simulate the OFDM system the utilizing different interleaved FEC codes. The design block diagram represents their specific operation .Here we only consider two FEC codes namely cyclic redundancy check (CRC) and convolution code (CC).

Short description of block diagram:

- Consider recorded audio as input signal
- Encode the information bits using either CRC or convolution encoder with generator matrix
- Use QPSK Modulation to convert the binary bits, 0and1, in to complex signal.
- Performed serial to parallel conversion.
- Use IFFT to generate OFDM signals.
- Performed cyclic prefix insertion
- Calculate the BER probability as a function of against different values of SNR and plot it accordingly.

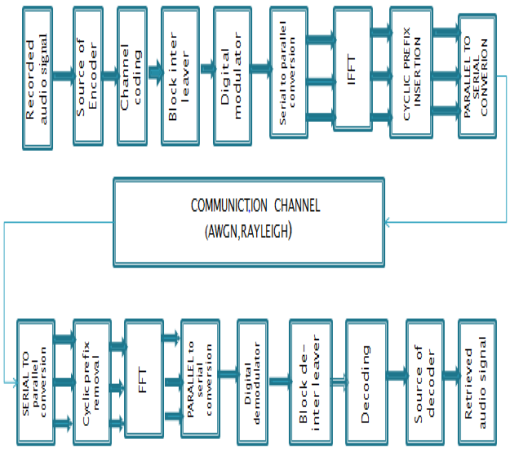

Fig2: OFDM Simulation model for transmission of recorded voice signal

V.DESCRIPTION OF DIFFERENT MODULATION SCHEMES

BPSK:

BPSK is also called PRK (or) 2-PSK.It uses Two phases separated by 180.It handles highest noise distortion before the demodulator reaches an incorrect position that make it most robust of all PSK's

General form of BPSK is

$S(t)=\sqrt{2Eb/Tb}\cos(2\Pi ft+\Pi(1-n))$,

It is a two phase modulation scheme. In this the 0's and 1's in binary message are represented by two different phase states in the carrier signal.

We can write BPSK wave form as

$$s1(t)=\sqrt{(Eb)}\Phi 1$$
$$s2(t)=\sqrt{(Eb)}\Phi 2$$

QPSK:

QPSK is also known as quadriphase PSK,4-PSK (or) 4-QAM.Although root concepts of QPSK and 4-QAM are different resulting modulated radio waves are same.

Implementation of QPSK indicates higher order BPSK

The general formula for this

$$S(t)=\sqrt{2Es/Ts}\cos(2\Pi fct+(2n-1)),$$

This results in a two dimensional signal space with unit basis function.

$\Phi(t)= \sqrt{2}/Ts \cos (2 \Pi fct)$

$\Phi(t)= \sqrt{2}/Ts \sin(2 \Pi fct)$

QAM:

Quadrature Amplitude Modulation (QAM) is an important modulation scheme as it allows for higher data rates and spectral efficiencies.

Quadrature Amplitude Modulation (QAM) schemes are attractive in terms of bandwidth efficiency and offer a number of sub channels with dil'erent integrities via both Gaussian and Rayleigh-fading channels.

QAM Aim to Express some of the basic theory in terms of relatively simple equations to provide some insight in to what is happening in the signal. The phase difference between the signals is 90 out of phase with each other.

In phase and Quadrature signals can be represented by

$I=A \cos (\Psi)$ and $Q= A \sin(\Psi)$

Using above two equations we can express the signal as

$\cos (\alpha+\beta)=\cos (\alpha) \cos(\beta)- \sin(\alpha) \sin(\beta)$

$A \cos(2\Pi ft+\Psi)=I \cos(2\Pi ft)-Q \sin(2\Pi ft)$

VI. Simulation Results and Discussion

In this we have done all simulation to achieve a desired Bit error probability. For our analysis ,we considered the AWGN channel and Rayleigh channel.Figer-3 shows the performance of BER of OFDM Using 16-QAM in AQGN channel

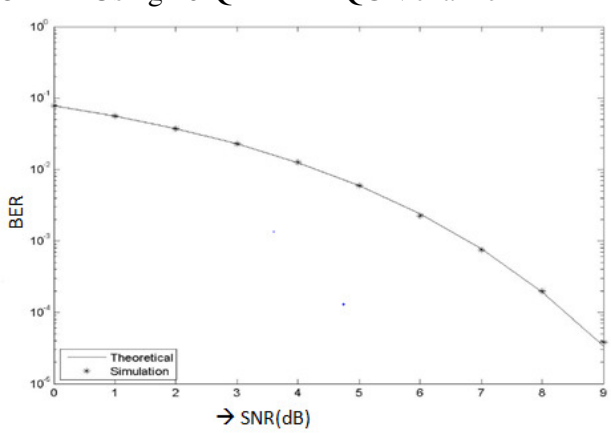

Fig3: shows the performance of BER of OFDM Using BPSK in AWGN channel

For realizing that, the effect of noise is represented in the base band with Gaussian random samples added to each signal sample. The signal to noise ratio is varied to show the effect of SNR on BER finally the theoretical BER, i.e. Q(sqrt(2*SNR))is also plotted to show the simulation.

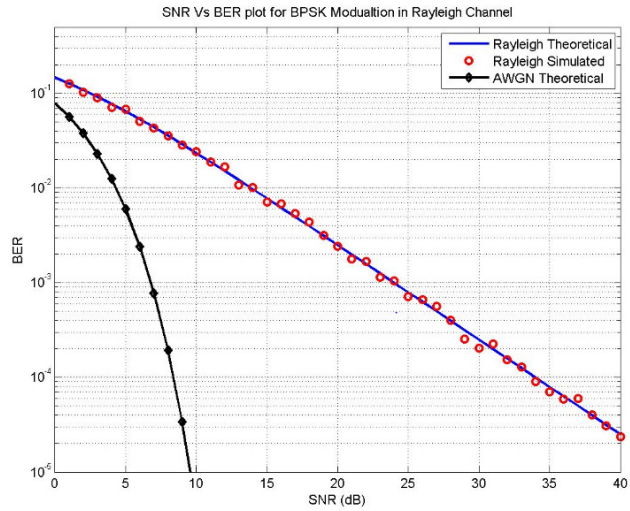

Fig4: shows the performance of BER of OFDM Using BPSK in Rayleigh channel

Generate random binary sequence of+1's and -1's. multiply the symbols with the channel and then add white gaussian noise.At the reciever,equilizeof(divide)the recieved symobls with noun channel.perform hard decision decoding and count the bit errors.Repeat for multiple values of Eb/No and plot the simulation and theoretical results.

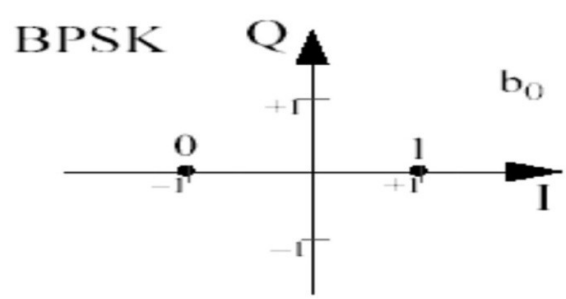

Fig5:BPSK scattern plot

- BPSK uses a finite number of phases, each assigned a unique pattern of binary digits. Usually, each phase encodes an equal number of bits.

- Each pattern of bits forms the symbol that is represented by the particular phase.
- BPSK is the simplest form of phase shift keying (PSK). It uses two phases which are separated by 180° and so can also be termed 2-PSK.
- It does not particularly matter exactly where the constellation points are positioned, and in this figure they are shown on the real axis, at 0° and 180°.

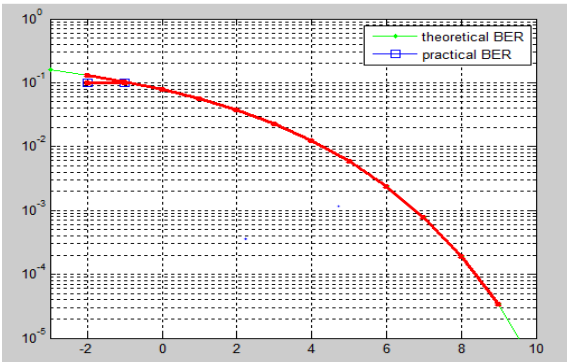

Fig6: shows the performance of BER of OFDM Using QPSK in AWGN channel

It is observe that the BER for a AWGN channel is less.so it has better performance

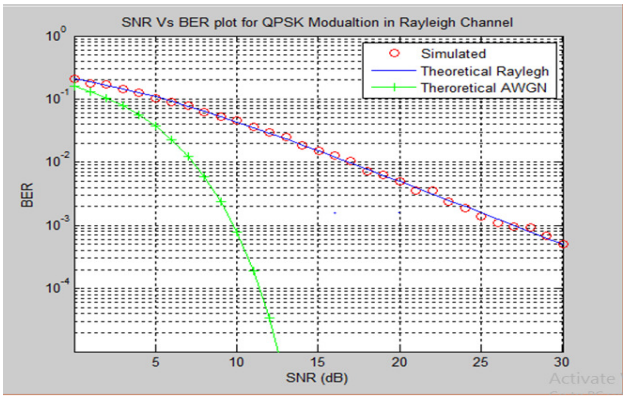

Fig7: shows the performance of BER of OFDM Using QPSK in Rayleigh channel

Which is more relistic representation of a wireless communication channel.We concidera single tap rayleigh fading channel .The complex channel coefficient is given as(a+j*b) wherea and b are Gaussian random variables withmean 0 and variance 0.5.We use the envelope of thise chnnlcoefficient in our simulation as any phase shift is easily removed by the receiver.

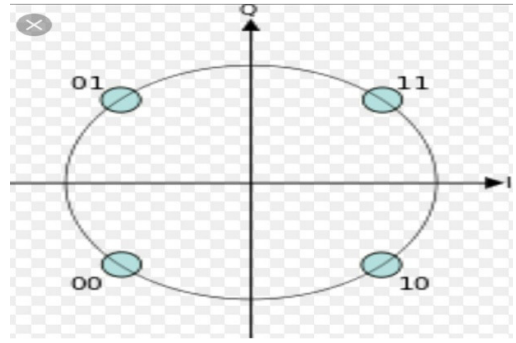

Fig8:QPSKscattern plot

- QPSK uses four points on the constellation diagram, equispaced around a circle. With four phases, QPSK can encode two bits per symbol.
- The mathematical analysis shows that QPSK can be used either to double the data rate compared with a BPSK system while maintaining the same bandwidth of the signal.

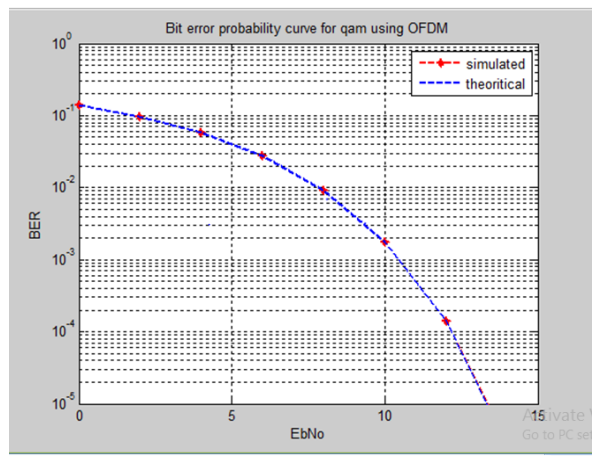

Fig9: shows the performance of BER of OFDM Using 16-QAM in AWGN channel

Quadrature Amplitude Modulation(QAM)is an importent modulation scheme as it allows for higher data rates and spectral efficiencies .the BER of QAM can be calculated through monte carlo simulation howeverthis becomes quite complex asthe constellation size of the modulation schemes increases.therfore theoritical approch is sometime

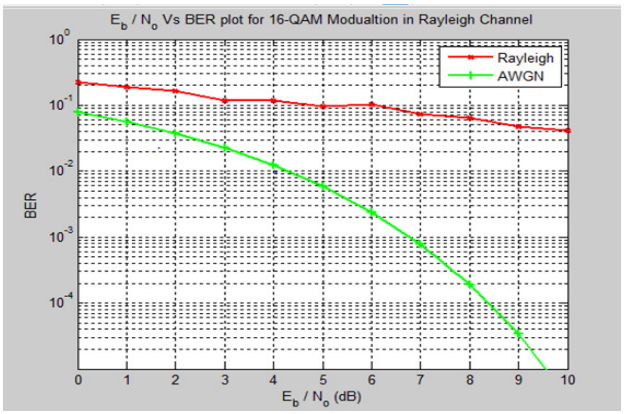

Fig10: shows the performance of BER of OFDM Using 16-QAM in Rayleigh channel

We use a method for tracking a rayleigh-fading channel with OFDM.So that multi-amplitude bit rate schemes such as 16QAM may be used in wireless communication channles.

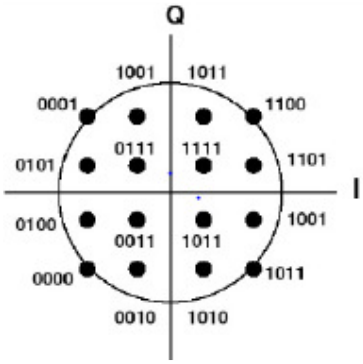

Fig11:16-bit QAM scattern plot

- QAM is the encoding of the information into a carrier wave by variation of the amplitude of both the carrier wave and a quadrature carrier that is 90 out of phase with the main carrier in accordance with two input signal.
- that is,the amplitude and the phase of carrier wave are simultaneously changed according to the information you want to transmit.
- In 16-state Quadrature amplitude modulation(16-QAM) there are four I- values and four Q-values. The symbol of rate is one fourth of the bit rate.

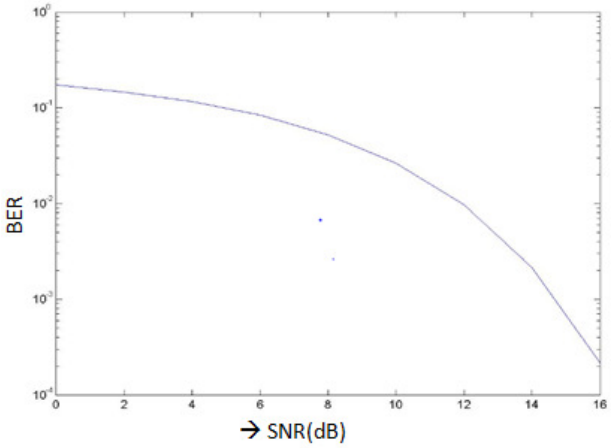

Fig12: shows the performance of BER of OFDM Using 64-QAM in Rayleigh channel

The 64-QAM modulation techniques shows better performance over rayeigh fadding channels.It is an importent modulation scheme being used in Wi-MAX and LTE. It allowes for transmission of 6-bits symbol which results in higher bit rate and spectrual efficiency.

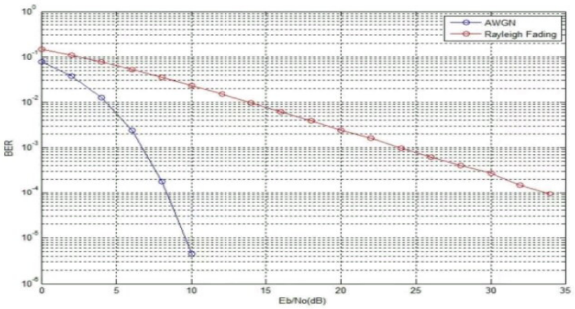

Fig13:BER performance of 64-QAM in AWGN& Rayleigh channel

This is very good modulation techniques compare to all other modulations techniques. In 64 QAM, AWGN channel has less bit error rate than Rayleigh channel

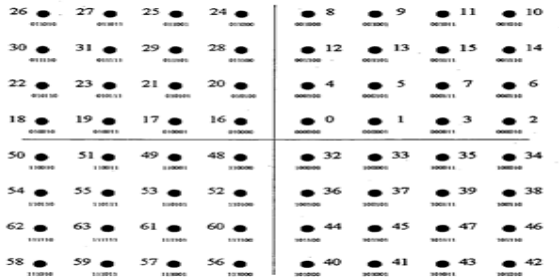

Fig14:64-bitQAM scattern plot

In 64-QAM phase noise is caused by transponders in the In-phase or quadrature phase modulation. It may produced in carrier recovery ,a possibility that can be excluded.

- In contrast to phase error, phase jitter is a statistical quantity that effects I-path ,Q-paths equally

VI.CONCLUSION

The tremendous world wide demand for high speed mobile wireless communications is rapidly growing.OFDM technology promises to bea key technique for achieveing the high data capacity and spectral efficiency requirements for wireless communication systems of the near future. As a result,the effect of FEC codes on considered OFDM system under AWGN as well as fading channel has ben investigated. from simulation results it is observed that interleaved convolutional encoded OFDM system better than that of interleaved cyclic redundancy check encoded OFDM system both AWGN and Fading channels.Convolution codes are used for the performance analysis of OFDM system.The simulation results include the performance analyis based on BER versus Eb/No plots with different modulation schemes such as BPSK,QPSK,16-QAM and 64-QAM..Among this The QAM modulation techniques shows better performance over AWGN and rayeigh fadding channels.

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