BER Performance Comparison of MIMO OFDM using Different Equalizers

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***Abstract*— The utilization of the combination of multiple antennas with the orthogonal frequency division multiple access technique called the MIMO-OFDM in wireless communication has improved the spectral efficiency and the coverage area. In wireless communication systems like MIMO-OFDM, the channel for the transmission of information could be varied quickly with time and may result in the loss of orthogonality of information signal causing ISI or overlapping of the signal bits. This would increase the bit error rate and the system performance degrades. In this paper we present performance comparison different equalizer techniques Zero Forcing Equalizer, minimum mean square error, maximum likelihood sequence estimation. The performance comparisons is shown in result section.**

I. INTRODUCTION

The continuous development of wireless communication has changed the view of exchanging information and pursue entertainment. It has made it possible to have the connectivity in pockets through cell phones. The applications are not only limited to voice telephony, but also the voice over internet, web browsing, streaming media, online gaming and much more. The target of future wireless communication systems is to offer high speed wireless access at high quality of service. The increasing requirements of multimedia services and the interest of users for internet related contents lead to increasing competition for high speed communications. This requires large bandwidth and the use of efficient transmission methods that would match the properties of wideband channels, especially in wireless environment where the channel is foundto be a scarce resource. MIMO-OFDM proves to be an excellent transmission technique in wireless environments

MIMO-OFDM-In MIMO system there is a path/channel among each of the transmitters and receiver antennas.

MIMO-OFDM shows brilliant transmission method in wireless environment. The MIMO-OFDM in combination shows beneficial, as MIMO means additional number of antennas which would offer greater bandwidths and OFDM means effective utilization of resources. The MIMO-OFDM technique have improved the spectral efficiency, diversity gains, and provides wide-ranging bandwidth management in widely used WLAN and WMAN networks such as Wi-Fi and WiMAX .

However, in wireless medium the information signal is traveling from the source to the destination through a number of different channels, termed as multipath. When the information propagates along various paths, power falls off mainly due to three effects i.e. packet loss, slow fading and fast fading. This outcome to the impairments in the signal behavior called ISI. The ISI raises the bit error rates and decreases the signal to noise ratio (SNR). This leads to the degradation in the performance of the system. Thus ISI is essential to mitigate. The ISI could be removed if the channel's fastly changing conditions could be estimated in some way. The channel is estimated by equalizing it. Thus equalization technique is used to battle inter symbol interference. Numerous equalizers are in literature and those which adapt themselves with channel's conditions called adaptive equalizers like DFE, FSE, LMS and RLS. A major work is done by the two main types of adaptive equalizers called linear and non-linear equalizers. The paper emphases on examining these types and tried to work on enhancing the performance of the wireless MIMO-OFDM system.

EQUALIZER-Equalizer is a digital filter which provides an approximate inverse of path/channel frequency response. Equalization is to alleviate the effects of ISI to reduce the probability of errors that occur without
suppression of ISI, but this reduction of ISI effect
has to be balanced with the prevention of noise power enhancement.

A. ZF EQUALIZER –ZF i.e. Zero Forcing Equalizer is a linear equalization algorithm used in communication system, which inverts the frequency response of the channel/path. The ZF Equalizer applies the inverse of the channel to the received signal, to restore the signal before the channel. The name Zero Forcing corresponds to taking down the ISI to zero in a noise free case. When ISI is significant compared to noise, this will be useful. For a channel with frequency response F(f) the zero forcing equalizer C(f) is constructed so that C(f) =1 / F(f). Thus, Combination of channels and equalizer gives a flat frequency response and linear phase F(f)C(f) = 1.

B. MMSE- A minimum mean square error i.e. MMSE estimator defines the approach which reduces the mean square error i.e. MSE, which is a common measure of estimator quality. The main feature of minimum mean square error i.e. MMSE equalizer is that it does not usually eliminate ISI completely but, reduces the total power of the noise and ISI components in the output. The MMSE estimator is then defined as the estimator achieving minimal MSE. In many circumstances, it is not possible to determine a closed form for MMSE estimator. In these cases, single possibility is to seek the technique reducing the MSE within a particular class, such as the class of linear estimators.

C. MLSE- The receiver use a maximum likelihood sequence estimation i.e. MLSE implemented by the means of Viterbi algorithm to recompense for the heavy selective distortions caused by multipath propagations. The performance of the receiver is calculated through a channel simulator appropriate for mobile communications. The results attained shows the good behaviour characteristics for the receiver in various modes of operation. Easy implementation of device using VLSI technology is expected for an optimized detector for the digital signals ,the priority is not to reconstruct the transmitter signals, but it should do the best estimation of the transmitted data with minimum possible number of errors. The receiver Emulate the distorted channels. All possible transmitted data streams are fed into distorted channel model. The receiver compares the time response with actual received signals and determines the most possible signal. In cases that are computationally straightforward, root mean square derivation can be use as the decision criterion for lowest error probability.

II. CALCULATION

SYSTEM MODEL- The system model taken for proposed technique is 2x2 MIMO-OFDM as shown in fig. 1

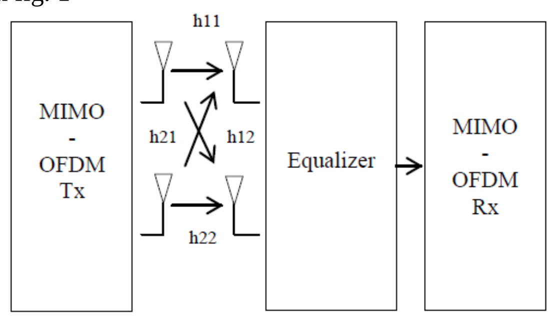

FIG.1 2x2 MIMO-OFDM model

The signal received on the first receiver antenna is

$$y_1=h_{11}x_1+h_{22}x_2+n_1$$

The signal received on the second receiver antenna is

$$y_2=h_{21}x_1+h_{22}x_2+n_2$$

y_1 and y_2 represents the signal received on the first and second antenna respectively,
h_{11} being the coefficient of channel sent by 1st transmit antenna to 1st receive antenna,
h_{12} being the coefficient of channel sent by 2nd transmit antenna to 2nd receive antenna,
h_{21} being the coefficient of channel sent by 1st transmit antenna to 2nd receive antenna,
h_{22} being the coefficient of channel sent by 2nd transmit antenna to 2nd receive antenna, x_1 and x_2

are the original symbols and n1 and n2 is the noise in 1st and 2nd receive antennas respectively.
Hence using above equations,

$$Y=HX+N$$

TABLE I. Parameters

No	Parameter	Value
1	Modulation technique	BPSK
2	Channel	Rayleigh
3	Mimo system	2X2
4	Equalizer	ZF,MMSE,MLSE
5	SNR level	0-25 dB
6	data	10^6 bits

STEPS-
1. Generate input signal bits (data)
2. Define SNR (0-25dB)
3. Make two copies of a signal for using it in 2x2 MIMO-OFDM system
4. Modulate (BPSK) the signal
5. Send the data through Rayleigh Channel and add AWGN noise
6. Implement ZF equalizer:
ZF Signal = W_{zf} .y
7. Implement MMSE equalizer:
Detected MMSE signal, $y_1 = W_{MMSE}$. Y
8.detection using mlse
$r=|y-Hx|^2$

III. SIMULATION RESULTS

The simulation test has been prepared for the MIMO technique. The parameters used in this are listed above in table 1

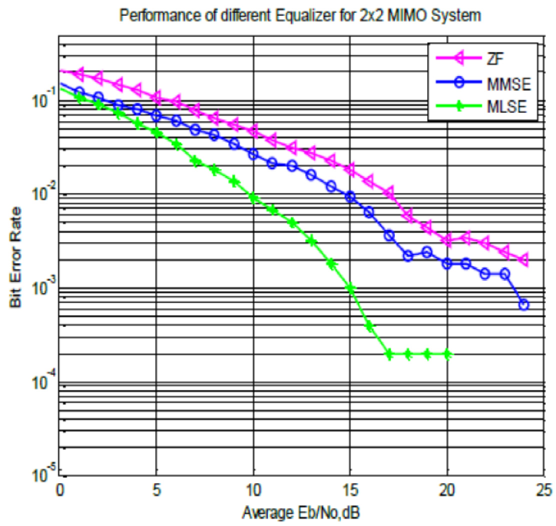

Fig 2. Performance of different equalizers for 2X2 mimo system

Table 2 Result

BER for ZF	BER for MMSE	BER for MLSE
0.001 at 17 dB	0.001 14 dB	0.001 at 10dB

IV. CONCLUSION

This paper is a simulation study on the performance comparison of MIMO-OFDM with different Equalizer using BPSK modulation technique.The test bench has been developed successfully for simulation and the BER 0.001 has been targeted by different equalizer on 2x2 MIMO System. The SNR levels for BER 0.001 are 10, 14 and 17 dB for MLSE, MMSE and ZF respectively. From the above following observations are made. The ML equalizer is the best of the three equalizers, as it provide inimum SNR value for corresponding BER value. The lower SNR for the same BER implies that it consumes much less power than the other two techniques. Hence we can conclude that BER performance of ML Equalizer is superior to zero forcing Equalizer and Minimum Mean Square Equalizers.

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