Genetic Algorithm Based Optimizing Channel Equalization in OFDM using Alamouti Codes

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***Abstract* - OFDM is generally employed for communication system by reason of its high transmission rate, high spectral efficiency, low sensitivity to time synchronization errors and it is robust against inter symbol interference and fading caused by multipath propagation .despite of its merits, OFDM experiences from high PAPR. In traditional approach many PAPR reduction techniques like PTS, SLM and for improvement of performance parameter equalizers were proposed. But traditional approaches were not efficient and effectively. So, there is need to find out the new algorithm which much better than traditional techniques with less computational complexity ,less time consuming and much more efficient. In this paper we are proposed hybridization of reduction techniques. We used companding along with Clipping and filtration techniques. OFDM receiver equalizer (MMSE) with Genetic Optimizing Algorithm are used for performance improvement. The performance parameters like BER,PSD and OUTAGE probability is improved using MMSE equalizer with Genetic optimizing algorithm of reduced PAPR Alamouti based OFDM signal.Moreover, Alamouti codes were used with orthogonal systems for achieving higher reliable information and PN Codes also used along with it because it has lesser error of probability and noise .The proposed system has lesser BER,PAPR,Outage probability and Better Power Spectral Density than the conventional system.**

***IndexTerms* - OFDM,MMSE,Comapnding transform ,Clipping and Filtering,Genetic Algorithm, Alamouti and PN Codes.**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing is recognized as a multi-carrier modulation scheme employed in various high data rate wireless standards for instance Digital Audio Broadcasting system, Digital Video Broadcasting system, Wireless Local Area Network and Broadband Wireless Applications . OFDM experiences high data transmission rate and it has the tendency to deal with interference produced by multi path and fading. In OFDM system, the data is transmitted in parallel over several uniformly spaced orthogonal subcarriers. The wireless radio channel is partitioned into numerous narrow-band frequency non-selective sub-channels. OFDM system abridges the process of channel equalization by estimating the channel transfer factor for every subcarrier by utilizing pilot symbols. In digital domain, OFDM is simply executed by inverse fast Fourier transform (IFFT) and fast Fourier transforms (FFT). The cause of inter-symbol interference (lSI) can be beat by using cyclic prefix (CP). OFDM system beras high peak-to-average power ratio (PAPR), by reason of superimposition of multiple orthogonal in-phase subcarriers attained during IFFT operation. High PAPR will formulate the signal to be further susceptible to the non-linearity of the High Power Amplifier. High PAPR OFDM signal necessitates costly HPA with large dynamic range for transmission devoid of distortion. This type of power amplifiers cannot be afforded in transportable wireless devices. High PAPR will outcome in poor bit-error rate (BER) performance, because of out-of-band spectral emissions. To compact with the dilemma of PAPR, various techniques of PAPR reduction, as Coding , selective mapping method, partial transmit sequence method and amplitude clipping and filtering have been proposed. Clipping and filtering is a signal distortion method of PAPR reduction, where, Clipping and filtering method is generally adequate method to lessen the high PAPR in OFDM system. Here clipping is the nonlinear operation in which rise in the band noise distortion, rise in the bit error rate also lower the spectral efficiency. here by using this method with filtering will provide good performance. Filtering after clipping will lessen out of band radiation. Companding transform method of PAPR reduction is also used along with clipping and Filtering method for more reduction of PAPR. Wireless radio channel has several unfavourable consequences which grounds the channel response to alter quickly. The consequences such like scattering and reflection grounds the radio signal to move in multiple paths. The received signal is deformed since of spreading in time and frequency. Thus, the unfavourable channel results have made channel equaliation as an important fraction of the wireless receiver design. In this paper, the Minimum Mean Square Error (MMSE) OFDM receiver performance is estimated with Genetic optimizing algorithm of reduced PAPR Alamouti based OFDM signal. Moreover, Alamouti codes were used with orthogonal systems for achieving higher reliable information and PN Codes also used along with it because it has lesser error of probability and noise.

II. PAPR REDUCTION ALGORITHM

A. AMPLITUDE CLIPPING AND FILTERING METHOD

A threshold value of the amplitude is set in this method and any sub-carrier having amplitude more than that value is clipped or that sub-carrier is filtered to bring out a lesser PAPR value. Amplitude clippng is informed as the easiest action which may be beneath taken for PAPR abbreviation in an OFDM system. clipping and filtering is an efficient method to get peak-to-average power ratio reduction in OFDM systems, but needs numerous iterations to reduce the peak re expansion difficulty. Clipping and Filtering (CF) algorithm supported on clipping noise cancellation method is employed which desires only one iteration to reduce PAPR and also alleviates the causes of in-band and out of band distortion.The signal distortion initiated by clipping operation can be minimized by executing a low pass filtering process on the clipped signal. However repeated clipping and filtering operation with K iterations involves (2K+1) FFT/IFFT operations. Based on central limit theorem, where N is the amplitude of OFDM signal is Gaussian spread, hence the clipping operation can be sighted as Gaussian input memory less non-linear system. According to Price's theorem, the clipping operation may be formed as a linear process

$$x_n^{(L)} = \alpha x_n^{(L)} + d_n^{(L)} \quad (1)$$

where attenuation factor

$$\alpha = \frac{E\{x_n^{(L)} d_n^{(L)}\}}{E\{|x_n^{(L)}|^2\}} \quad (2)$$

The total clipping noise after K iterations is premeditated based on the clipping noise created after first iteration is expressed by the parameter as

$$\beta = \frac{1-(1-\alpha)^{3K/2}}{1-(1-\alpha)^{3/2}} \quad (3)$$

the clipped OFDM signal can be computed as

$$X_{KC}^{(L)} = [X_K]_{K=0}^{(LN-1)} - \beta D_K \quad (4)$$

Filtering operation takes place in this transformation in order to eliminate the out of band radiation. Abolition of clipping noise in a clipped and filtered signal.

$$x_n = x_{nc} - E[d_n^{(L)}]$$

$$x_{nc} - \frac{\int |x| \geq 0 (x_n^{(L)} - \alpha x_n^{(L)}) e^{|x-x_n|^2/var(x_n^{(L)})}\, dx}{\pi Var(x_n^{(L)})} \quad (5)$$

Where, α Attenuation factor

β Parameter to estimate clipping noise

$X_K]_{K=0}^{N-1}$ OFDM symbol in frequency domain $x_n^{(L)}$ Oversampled OFDM symbol in time domain

$[X_K]_{K=0}^{LN-1}$ Zero-padded OFDM symbol in frequency domain

$d_n^{(L)}$ Time domain clipping noise

D_K Frequency domain clipping noise

X_{nc} Clipped and filtered OFDM signal in time domain

$X_{Kc}^{(L)}$ Clipped and filtered OFDM signal in frequency domain

X_N Clipping noise reduced clipped and filtered OFDM signal in time domain

B. COMPANDING TRANSFORM METHOD

The companding is method of reduction PAPR of OFDM signal. Our approach in this work engages applying *u*-law companding at the transmitter to diminish the value PAPR of the conveyed waveform so as to diminish distortion during the transmit amplifier and authorize operation nearer to amplifier saturation. Values of *u* ranging between 0.125 and 64 were employed in the study while the optimal performance was found to exist in within this variety of process.

Let sdat(*n*) be the baseband OFDM signal linked with the data symbol. In this case of *u*-law companding for a choosed *u*, the compressed OFDM signal, sc(*n*), is created as

$$s_c(n) = K(u)S_{max}\frac{\ln\left[1+u^{|S_{dat}(n)|}/_{S_{max}}\right]}{\ln\left[1+u\right]}sign \tag{6}$$

Where (7)

$$S_{max} = \max\left(S_{dat}(n)\right)$$

where K(*u*) is a normalization constant as that the average power of the companded signal is equivalent to the average power of the uncompanded signal. A planned estimatation for K(*u*) is

$$K(u) \approx \frac{\ln\left(1+u\right)}{u} \tag{8}$$

III. MINIMUM MEAN SQUARE CHANNEL EQUALIZATION

Delay spread grounds harmful effects of the wireless channel ensuing in lSI at the receiver. Channel equalization is a signal processing method at the receiver to alleviate the effects of lSI. Channel equalization employ pilot tones in the transmitted signal to approximate the channel state data. The equalizing process is abridged in OFDM systems which engages the approximate of the channel response factor for every orthogonal subcarrier . A Minimum Mean Square Error (MMSE) estimator defines the approach which diminish the mean square error (MSE), which is a common evaluate of estimator quality. The main attribute of MMSE equalizer, is that it does not generally reduce ISI completely but , reduce the total power of the noise and ISI components in the output.

For a system described by

$$Y=HX+N \tag{9}$$

The Minimum mean square error approach seeks to locate a coefficient *W* which lessen the criterion

$$E\{[W_{y-x}][W_{y-x}]^H\} \tag{10}$$

To resolve for x, we require to locate a matrix W which gratifies *WH* =I. The Minimum Mean Square Error detector for gathering this constraint is given by,

$$W = [H^H H + NI]^{-1}H^H \tag{11}$$

This matrix is acknowledged as the Pseudo inverse for the general $m \times n$ matrix

IV. GENETIC ALGORITHM

GA is an optimization algorithm in which the fittest survives. The algorithm works on natural criterion that takes place in the operation of genetics. The operations on which GA works are reproduction, crossover and mutation. A fitness function is calculated on the basis of which new population is created every time. New population is created by applying crossover and mutation techniques and the results are compared with the initial population created. The best optimized results are saved for computing performance parameters. Now, what basically is done in GA is first of all calculation of fitness function. This fitness function is then used to apply crossover. In crossover certain bits of one population are swapped with the bits of second population and as a result a whole new population is created. The results are then obtained by using crossover applied population. Then mutation is used. In mutation any bit of population is inverted which again creates a new set of population so will generate different results. The results of the initial population, crossover applied population and mutation applied population are compared and the best optimized results are saved.

V. METHODOLOGY OF PROPOSED WORK

The methodology of the proposed work is defined below. In this proposed work the genetic algorithm is used for optimizing the results obtained

- Initially the Alamouti based OFDM with PN Codes transmitter is set up. The signal is send to the receiver.
- After the signal is send , apply the PAPR reduction technique
- Firstly apply companding technique on the signal to reduce the effect of PAPR, as this the major problem in the signal and should be minimized.
- After applying the companding technique, next step is to do the clipping and filtering of the companded signal.
- After applying the PAPR reduction technique, next step is to apply MMSE equalizer on the signal obtained .
- Next step after the signal equalization is to apply the Genetic algorithm after that the parameters of the genetic algorithm are initialized.
- In this step the fitness function is defined, after defining the fitness function next step is to generate the population.
- Now update the population generated by using crossover, after updating by using cross over, next the population is updated by using mutation.
- In this step the initial BER & PAPR is compared with the updated BER. This updated BER & PAPR is obtained by using crossover and mutation
- If the updated BER& PAPR is less than the initial BER than it is saved. if updated BER & PAPR is more than the initial BER & PAPR than go back to step no .8
- Finally the calculation of the performance parameters are done that will depict the system performance.

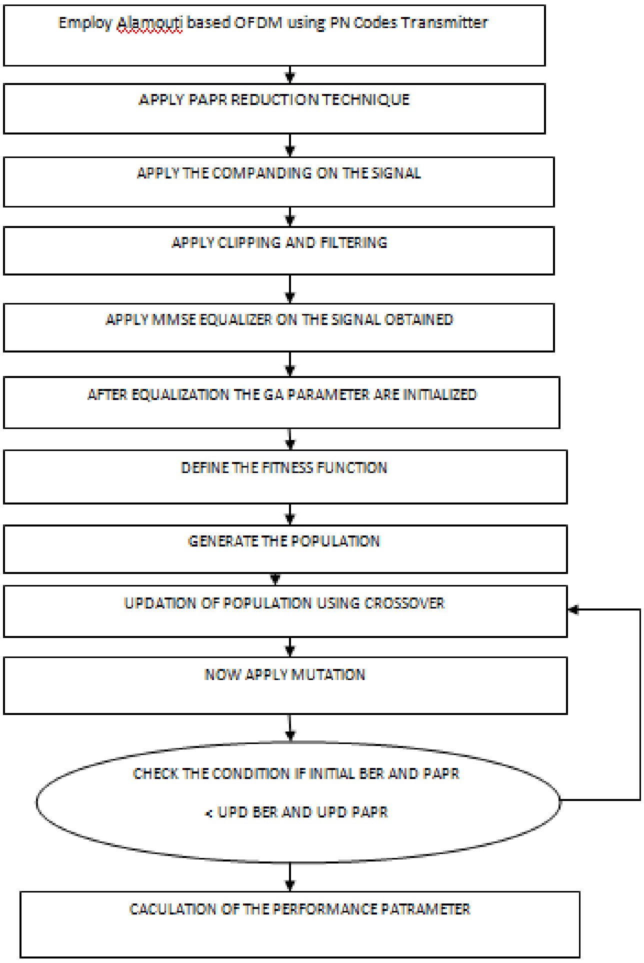

Fig.1.Methodology of Proposed work

VI. SIMULATION RESULTS

The MMSE equalizer and PAPR reduction algorithm companding along with clipping and filtering with genetic optimizing algorithm has been developed in MATLAB for enhancing the performance parameters BER,PAPR,PSD AND outage probability of Alamouti based OFDM systems . Simulation results have been obtained by executing the program in number of times. The results are shown below:

A. BER PERFORMANCE OF ALAMOUTI BASED OFDM WITH PN CODES AND OFDM

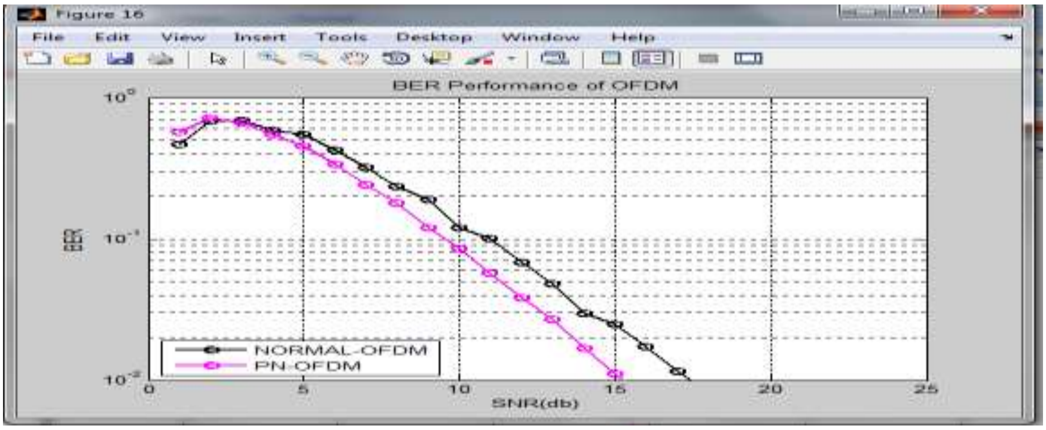

Fig.2. shows comparison the BER performance of Alamouti based OFDM with PN codes and OFDM

B. BER PERFORMANCE OF MMSE EQUALIZER WITH AND WITHOUT GA

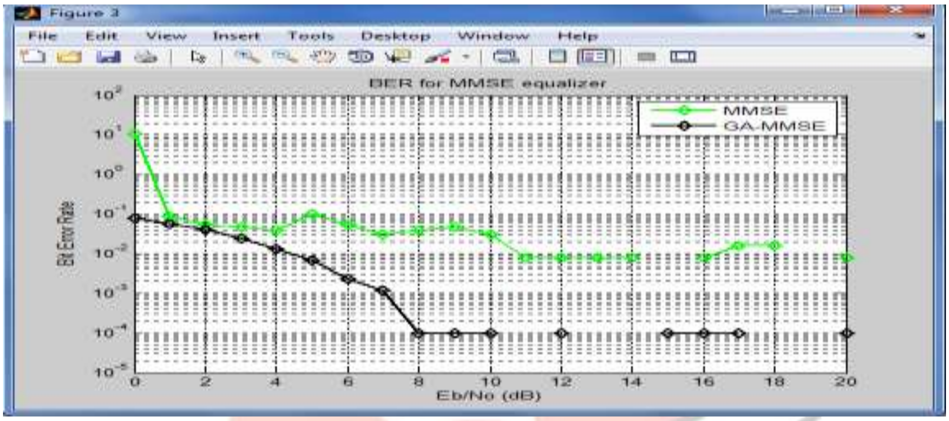

Fig.3. shows the BER performance of MMSE equalizer with and without GA

This figure depicts the BER performance of MMSE Equalizer with and without GA.MMSE equalizer with GA performs better than MMSE Equalizer. The MMSE equalizer with GA has lesser BER than MMSE equalizer.

C. FITNESS FUNCTION

A fitness function is a kind of objective function which is employed to abridge, as a single figure of merit, how nearly a specified design solution is to attaining the set ambitions. In our thesis work we define a fitness function

FitnessBer=sum(Tber)+mean(PAPR_Normal)

for achieving the better performance parameter

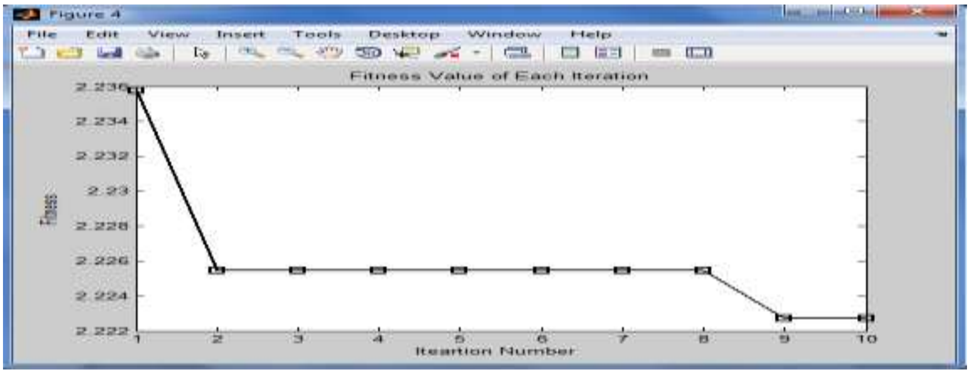

Fig.4. shows the Fitness function

This figure shows the fitness function of each iteration in Genetic Algorithm.

D.COMPARISION OF PAPR PERFORFANCE WITH PROPOSED AND ORIGINAL SYSTEM

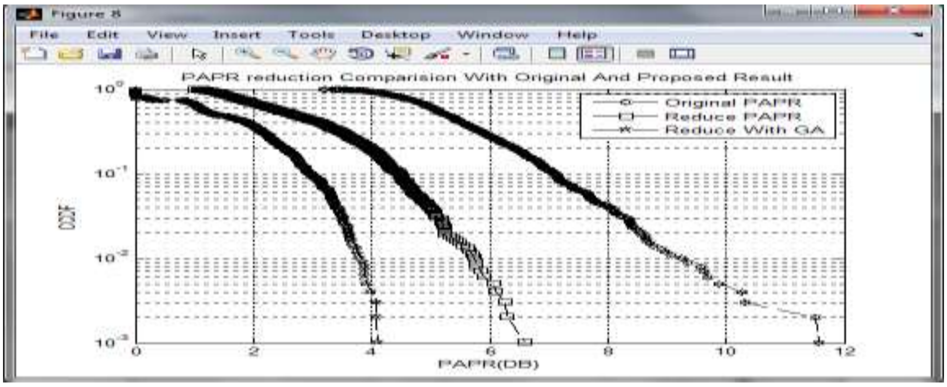

Fig.5 shows the PAPR performance with Proposed and Original system

This figure shows the comparision of PAPR performance with proposed and original system.The hybridization reduction techniques after Genetic algorithm performs better .The papr value of proposed system is less than the original system .At CCDF 10^{-3} ,the PAPR performance value of caompandind along woith clipping and filtering after GA, before GA and Original system is 4.0952,6.6966,11.5688.

E. COMPARISION OF POWER SPECTRAL DENSITY BEFORE AND AFTER GA

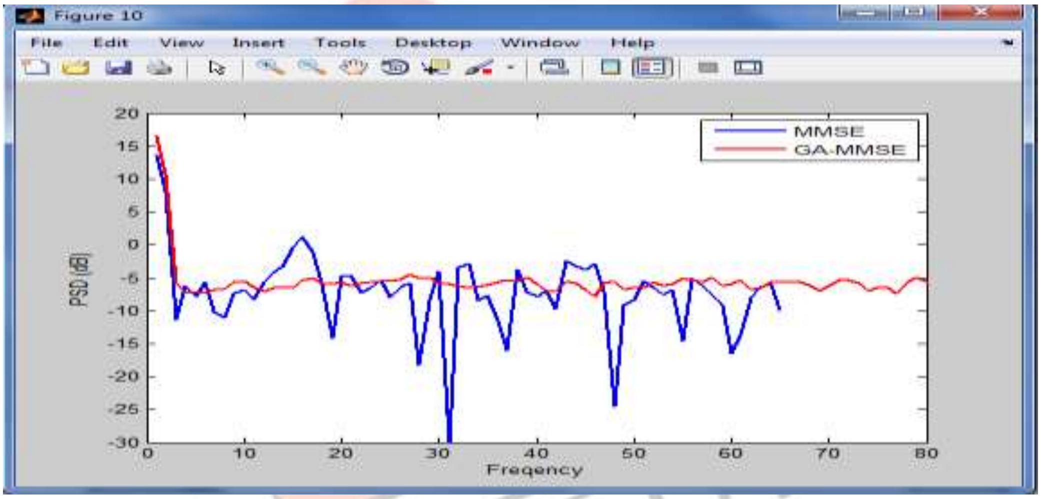

Fig.6. shows the PSD after GA and Before GA

This figure depicts the power spectral density of OFDM after and before GA.The proposed system shows the better result .power spectral density of ofdm after GA is better than OFDM .

F. COMPARISION OF OUTAGE PROBABILITY OF OFDM AFTER AND BEFORE GA

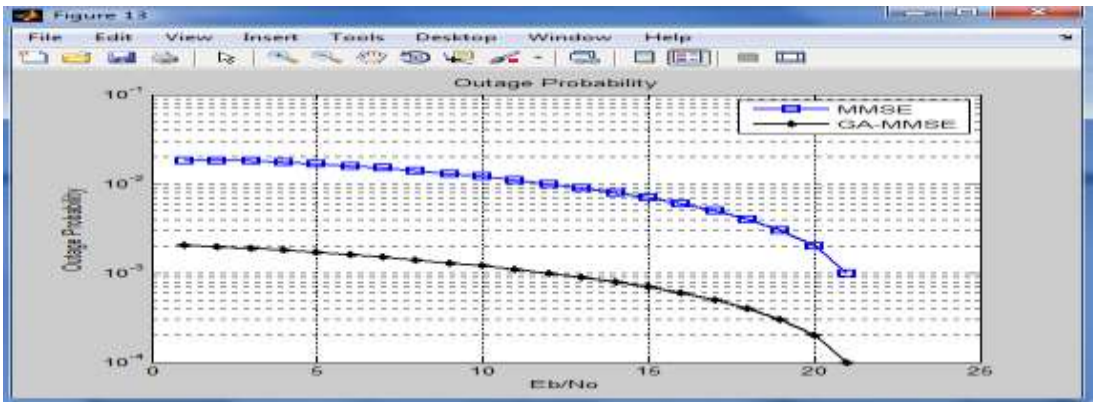

Fig.7. shows the comparision of Outage Probability after and before GA

This figure depicts the comparision of outage probability after and before GA .The outage probability of proposed system is lesser than the original system.

VII. CONCLUSION & FUTURE SCOPE

The new proposed technique proved to be better and efficient than the conventional techniques. It is concluded from the experimental results that the performance parameter improved by proposed method.The performance parameters like BER,PSD and OUTAGE probability was improved using MMSE equalizer with Genetic optimizing algorithm of reduced PAPR Alamouti based OFDM signal. The PAPR was reduced using hybridization reduction method companding along with clipping and filtering with GA. Hence, it was concluded that the new technique in performance parameter improvement is done with MMSE equalizer with Genetic Optimizing Algorithm of reduced PAPR of Alamouti with Pn codes based OFDM yields better and efficient results than the conventional techniques. Moreover, Alamouti codes were used with orthogonal systems for achieving higher reliable information and PN Codes also used along with it because it has lesser error of probability and noise. The proposed system has lesser BER, PAPR, Outage probability and Better Power Spectral Density than the conventional system.Performance parameters of the system can be improved by using hybrid approach of optimizing algorithm.

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