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Performance Enhancement of Channel Estimation in MIMO OFMD in Presences of ICI

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Abstract – Wireless media depends on three parameters which defines its quality. These parameters are its transmission range, transmission rate and reliability. In OFDM, quality of one paramter can be increased on the cost of decreasing the other two parameters. The three parameters can be improved together by combining MIMO with OFDM. Channel estimation is an essential tasks of MIMO-OFDM system. This task can be excellently achieved by genetic algorithm. In this paper along with OFDM different systems are being used along with diiferent modulation techniques. In this, we are applying a new Modulation scheme called as the Magnitude Keyed Modulation combined with OFDM system, it provides immunity from ICI and thus improves the overall system performance, maintaining a low PAPR ,high SNR and improvement in Bit Error Rate performance.

Index Terms – Orthogonal Frequency Division Multiplexing (OFDM), Multiple input multiple output(MIMO), Genetic algorithm (GA), channel estimation

1. INTRODUCTION

Presently wireless communication system has received a great attention because of rapidly increasing demand for communication with high data rate. So various digital wireless communication techniques have been developed to fulfill our day to day necessities. These system many a times have the weaknesses like incomplete bandwidth, bad communicated channel, complex mobile environment, channel estimation and the quality of service under incomplete service time. To satisfy these demands, high-speed wireless communication and higher network capacity are required. The MIMO-OFDM system which is a combination of MIMO and OFDM systems is currently the best solution to meet these requirements.

Accurate channel estimation is essential for system performance and this is the major challenge for practical MIMO-OFDM systems [2].Conventionally channel estimation methods was categorized as: preamble which is used in time domain [3] orthogonal pilot which is frequency domain based aided [4] methods. The pilot pattern and the method of channel estimation used in MIMO-OFDM system couldn't eliminate the same frequency interference caused by the OFDM frequency among different transmit-receive antenna couples. For this problems, new approach was proposed a method of channel estimation in MIMO OFDM combining orthogonal genetic optimization.

The proposed scheme firstly relies on a pseudo random preamble which is identical for all regular antennas to acquire the partial common support and inverse transmission scheme by using Genetic search helps fast convergence and can handle large allocations of subcarriers to users without performance deprivation theorem which utilizing the sparse common support property of the 2*2 MIMO channels. Frequency domain orthogonal pilots are used for the accurate channel recovery. The proposed scheme is to evaluate by using ICI reduction using Genetic Multiple Input OFDM(GM-OFDM) technique that provide high spectral efficeiency, more robustness, better performance than the conventional MIMO-OFDM schemes.

2. SYSTEM MODEL

In wireless communication an issue to increase the capacity has always been there so to fullfill it MIMO (Multiple Input Multiple Output) system architecture is used to increase that capacity substantially. Usually one of the most common problem in wireless comuniction is fading but MIMO channels uses the fading to increase the capacity. In MIMO systems there are different transmits signals from each transmit element so that the receiving antenna array receives a superposition of all the transmitted signals.

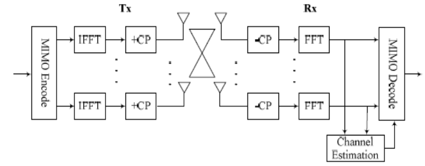

Fig.I System Model of MIMO OFDM

Let there be N_T transmit antennas and N_R receive antennas. If *n*th antenna of receiver and the *m*th antenna of transmitter is considered its channel vector is characterized by channel impulse response that is:

$$h_{nm} = \sum_{i=0}^{L-1} h_{nm}(i)\delta(\tau - \tau_i) \qquad (1)$$

No of subcarriers be K, for m_{th} antenna the transmitted OFDM modulated signals are $X_m(k)$. Cyclic Prefix is inserted in an OFDM symbol to avoid ISI. At the receiver, K^{th} subcarrier gives the signal at the receiver from the n^{th} receiving antenna which is given by:

$$Y_n(k) = \sum_{m=1}^{N_r} H_{nm}(k)X_m(k) + N_n(k) \quad (2)$$

$H_{nm}(k)$ is the channel frequency response . It can further be written as :

$$H_{nm}(k) = \sum_{l=0}^{L-1} h_{nm}(l)W_k^{kl} \quad (3)$$

Where:

$$W_k^{kl} = e^{-2j\pi kl/_k} \quad (4)$$

Pilots are used for channel estimation which finds the channel state information in MIMO-OFDM. Let the subcarrier be $k_1, k_2 \dots\dots.. k_p$ for each N_T antennas and pilots are placed at these subcarriers. Matrix form of Equation 2 is:

$$\widetilde{Y_n} = \sum_{m=1}^{N_T} diag(\widetilde{X_m})\,\widetilde{H_{nm}} + \widetilde{N_n}$$

$$\widetilde{Y_n} = \sum_{m=1}^{N_T} diag(\widetilde{X_m})\,F_L h_{nm} + \widetilde{N_n}$$

The various symbol denotes:

$\widetilde{Y_n}$ is the received pilot vector.

$\widetilde{X_m}$ is the transmitted pilot vector.

$\widetilde{H_{nm}}$ is the channel frequency response.

h_{nm} is the channel impulse response and can be written as:

F is a K-point DFT.

The final expression can be derived as :

Y=Fh + N

where ,

$$h = \left[h_{n1}, h_{n2}, \dots\dots\dots h_{nN_T}\right]^T$$

The channel state information is denoted by 'h' which has to be estimated.

The channel is estimated in the receiver by transmitted training sequence called pilots. For a one-antenna system one can apply the Shannon formula:

$$C = Log_2\left(1 + S/_N\right) \quad (5)$$

Where C is the channel and is measured in [Bits/(sec*Hz)], B is the bandwidth and S/N is the signal-to-noise ratio. This is the maximum rate the channel can give with arbitrary low probability of bit errors (allowing infinite coding delay). Hence, it is an upper limit on the practical achievable bit-rate.

When one uses a MIMO system one have to use a generalized version of Shannon's formula:

$$C = Log_2\left(\det\left(I + \frac{\rho_k \cdot HH^*}{\sigma^2}\right)\right) = \sum_{k=1}^{n} Log_2\left(1 + \frac{\rho_k}{\sigma^2}\lambda_k\right) \quad (6)$$

ρ_k , k=1,2,…,n is the transmitted energy through channel "mode" k with power gain λ_k .

3. CHANNEL ESTIMATION IN MIMO OFDM

The previously used algorithms for channel estimation had drawbacks like channel estimation accuracy and validity was not precise enough, high computational complexities and also they had iterative time delay.

Some had high MSE. Thus the main intention of the proposed GA-based optimized FFT channel estimation is to discover the best channel with less MSE than the existing channel estimations. In the proposed method, the existing estimated channel is randomly mutated by GA, and the best channel matrix is identified based on the fitness function which is given as

Fitness = $[(H-HL)/H]^2$

Where H is the reference channel. Then, MSE is calculated for the above channel. The same steps are performed for repeated number of iterations.

In the next step, a new channel is obtained by the crossover of FFT-LS and FFT-MMSE channel operation followed by mutation. Then, the best channel matrix is selected based on the fitness, and MSE is calculated as in the previous operations. Finally, the best channel with low MSE is selected from the group of FFT-LS, FFT-MMSE and FFT-LS/MMSE channels.

4. STEPS TO EXECUTE GENETIC ALGORITHM

- Originates the process of the algorithm by initializing a random initial population which is a set of potential solutions or points in the search space.
- Computes the fitness value of each member or individual of the present population in order to create new community or generation.
- On the basis of fitness value, selection of members called genesis or parents takes place.
- Some of the individuals having lower fitness values considered as Elite that are passed directly to the next generation.
- Genetic solution reproduction depends upon two operators that are Crossover and Mutation.

- Crossover guarantees the algorithm to evaluate the best genes from discrete individuals and then recombined them to have increased average fitness value. It creates a potentially imperious progenies for the next generation.
- Mutation applies random changes to an individual in the present generation that will provide genetic diversity. It also enables algorithm to search over a broader space for reducing the untimely convergence that causes trapping of algorithm in global minima.
- Replaces the present population with the progenies to create the next generation.

5. SIMULATION RESULTS

The input parameter used in simulation is shown in

Table-1

PARAMETER	EXTENDED VALUES
FFT size. N-FFT	64
Number of used subcarriers. N-DSC	52
FFT Sampling frequency	24MHz
Subcarrier with ICI	N=16
Number of population size	256
Maximum generation	100
Modulation Schemes	Modulation Schemes, QPSK,PSK
Probability-mutation	0.003
Length genomes length	1024

Table 1: Input Parameter for Status Value in Proposed Simulation Model.

In this different communication schemes are being used like SC OFDM, GA OFDM and CDMA. And different modulation schemes are being applied on these data communication techniques. Apart from this inter carrier interference is also present in the schemes applied on the communication techniques.

Simulation of MIMO-OFDM is done over Genetic Multiplexing using Matlab, Performance metrics average achievable rate were taken to analyze the system performance. The results are as follows:

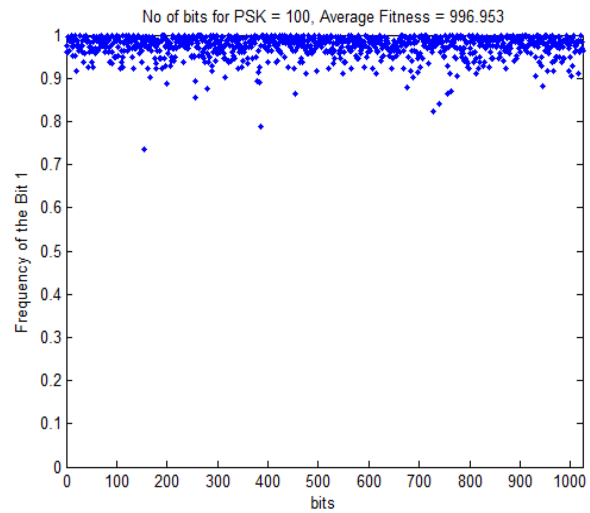

Fig1

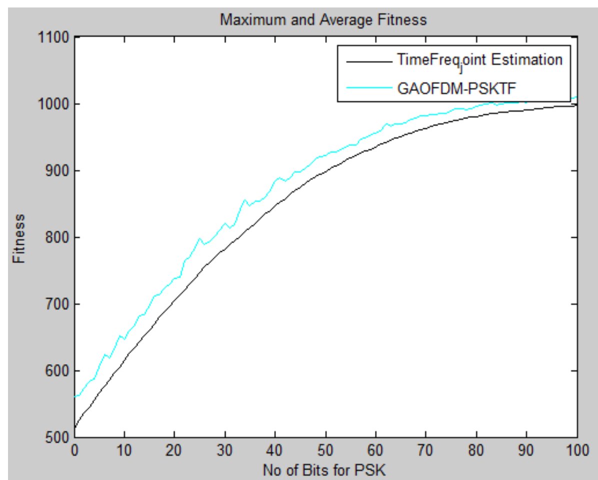

Fig 2.

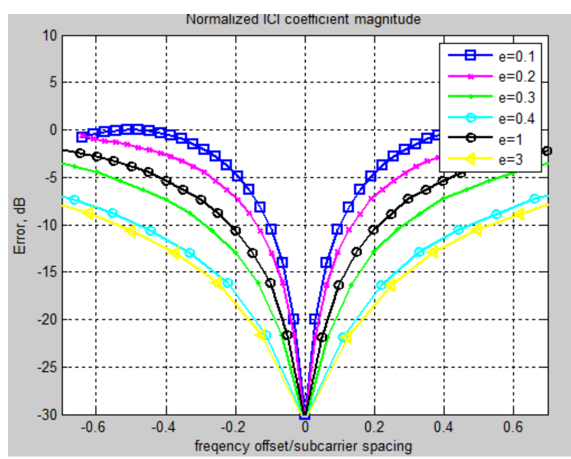

Fig 3

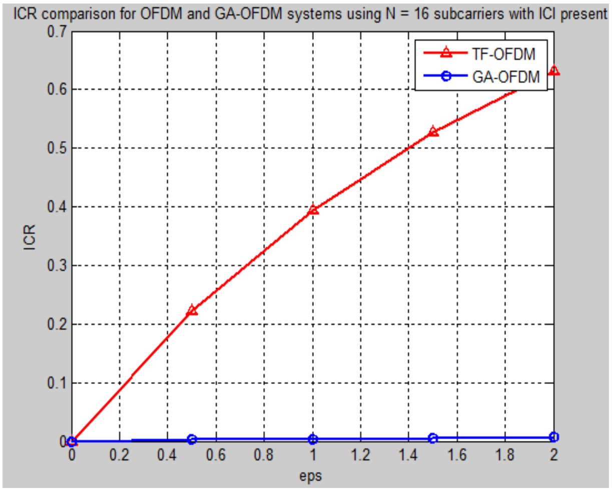

Fig 4

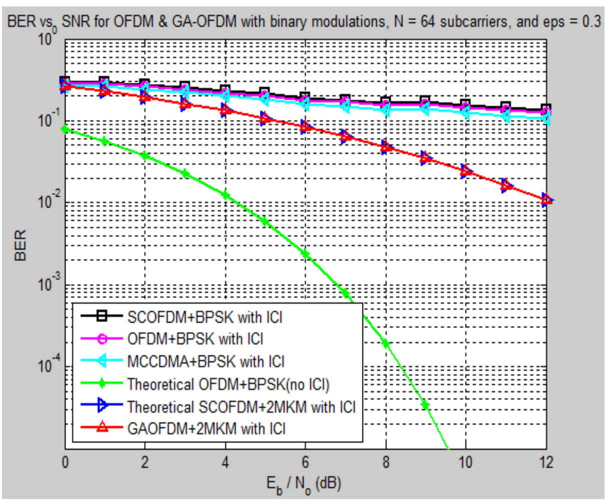

Fig 5

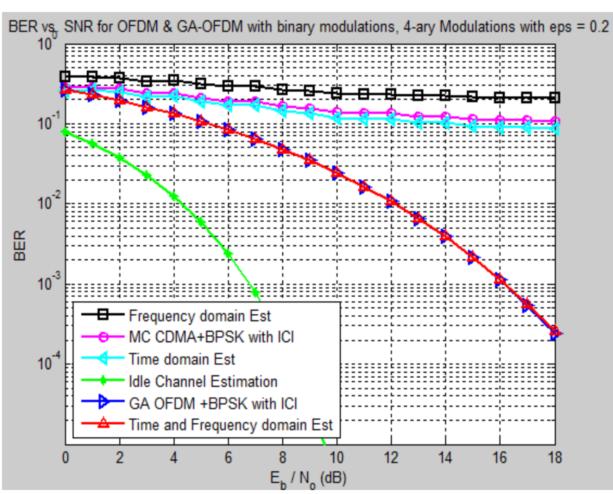

Fig. 6

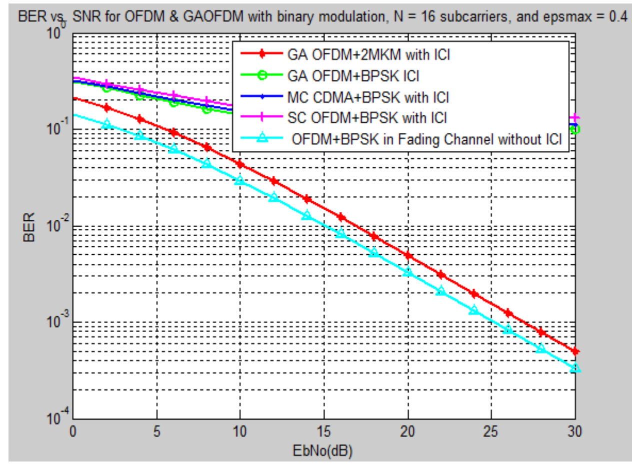

Fig.7

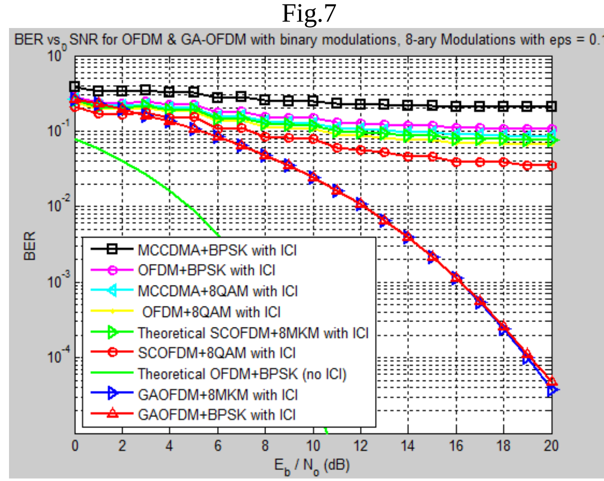

Fig. 8

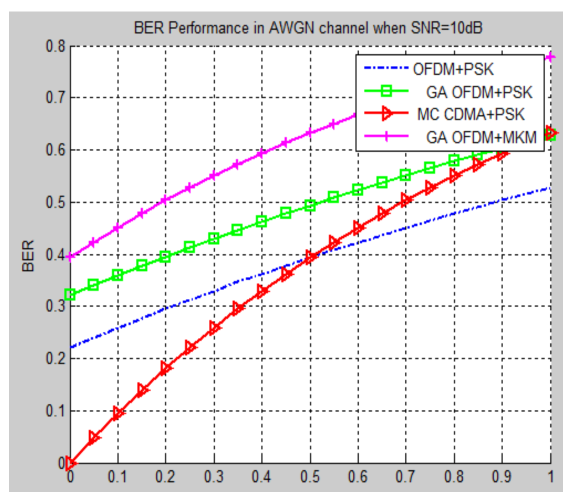

Fig 9

In this proposed work we see the relation between BER and SNR for different data communication techniques with different modulation schemes. Fig 1 shows the generation of subcarriers, out of 1000 bits 996.953 is being received. In Fig 2 as number of bits increases fitness reduces ie.,reduction in reception of bits transmitted at the receiver. In Fig 3 it shows the relation between carrier frequency offset and ICR. Fig 4 ,5,6 ,7and 8shows the relation between BER and SNR using different techniques using different modulation at different coefficient of ICI .

Thus we see that Genetic algorithm used for channel estimation increases the spectral efficiency than the previously used algorithm.

TABLE. 2
Comparison Table of Spectral Efficiency

Methods	Spectral Efficiency
Time domain preamble based scheme	76.19%
Frequency domain comb type pilot based scheme	70.59%
Time Frequency joint sparse SASOMP based scheme(base)	80.82%
Proposed - Genetic Algorithm Based scheme	93.20%

TABLE.3
Comparison Table of BER

SNR	ε	GA OFDM	GA OFDM	SC OFDM	SC OFDM	OFDM	CDMA
		8MKM	BPSK	8MKM	8QAM	BPSK	BPSK
10	.1	.098	.099	.1	.094	.98	.99
20	.1	$8.8*10^{-5}$	$8.5*10^{-5}$	1	.098	1	1

TABLE. 4
Comparison Table of BER

SNR	ε	GA OFDM	SC OFDM	OFDM	CDMA
		2MKM	2MKM	BPSK	BPSK
10	.3	.09852	.0990	1	.0981

6. CONCLUSION

In this the performance evaluation of the GA-OFDM channel estimation over the multipath AWGN channels using MIMO-OFDM is presented. Genetic algorithm has the advantages of significantly less computational complexity, greater robustness and is closer to the optimal solution. Hence in this we are using Genetic multiplexing algorithm based channel estimator to accomplish these tasks and to achieve results near to optimal solution. Comparisons between the results obtain between different techniques has been shown for better understanding. The performance of the OFDM system is compared by varying the size of the modulation. In this we analyzed various modulation schemes used in wireless link adaptation. We see that GA-OFDM technology is very fast and advance technique used for mobile purposes. And we get better results when GA-OFDM is modulated either with MKM or BPSK. This technology provides various protocols and features as compared to older technologies. Wireless communications are expanding their field of action.

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