A Novel approach of estimation of noise parameter in SCFDMA channel by Grey Wolf Optimization

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Abstract - Substitution to the problem employed SCFDMA system for its uplink transmission. SCFDMA based communication systems provide low Peak-to-Average-Power Ratio, which in turn utilises power amplifiers more efficiently and saves battery power of User equipment (UE)In SCFDMA systems, channel estimation and channel equalization play a key role in overcoming distortions caused by phenomena like fading, delay spread and multipath effect. In this thesis, channel estimation and equalization techniques are analyzed to improve the performance of SCFDMA system. The channel estimation techniques considered here are estimation using wiener filter and frequency domain approach. Prior Channel estimation leads to simple equalization. In this paper optimize the Flower pollination algorithm analysis and grey wolf optimization (GWO) by BER (bit error rate) which reduce in optimization approach when increase the SNR. If compare FPA and GWO, GWO improve more BER.

I. INTRODUCTION

Orthogonal Frequency Division Multiple Access is a multiple access scheme employed in various communication system for transmission of data. OFDMA has been selected by various standards like IEEE as its physical layer interface for next generation wireless communication systems. OFDMA is a multichannel system in which many orthogonal sub-carrier signals which are closely spaced and having overlapped spectrum are employed for transmission of information. These orthogonal sub–carriers do not interfere with each other and provide robustness to channel fading and Inter Symbol Interference (ISI).

Orthogonal Frequency Division multiplexing is a special case of FDM where each subcarrier is made orthogonal to all other subcarriers as shown in Fig 1.1. This technique allows overlapping of the different subcarriers as compared to conventional guard band between carriers and hence leads to good spectrum utilizations.

Subcarrier signals are used to carry the input data. These subcarrier signals are generated using the Nyquist criterion for the multi-carriers. The data to be transmitted is first of all divided into different parallel data streams respectively for each of the sub-carrier. Each of the sub-carrier is modulated by using modulation schemes like QPSK, QAM, BPSK etc. at low symbol rate. Each of these modulation techniques have their own set of advantages which are offered to the communication system. An OFDM system also employ other operations like IFFT, FFT, addition and removal of cyclic prefix , serial-to-parallel as well as parallel-to-serial conversion, digital to analog and analog to digital conversion process.

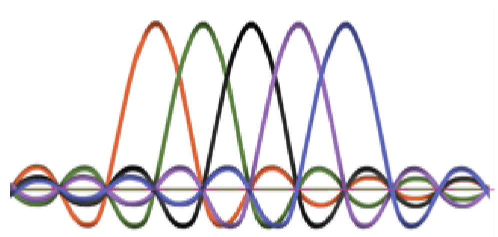

Figure 1.1 Block diagram representation of an OFDM system:

II. LITERATURE REVIEW

D. J. Krusienski et al. in [1] gave an application of ADAPTIVE techniques for generalizing nonlinear adaptive and recursive filter structure designs. ADAPTIVE is an optimization algorithm that can perform a randomized and structural search for some unknown parameter space. It manipulates a population of estimate of a parameter to converge onto a particular desired solution. These types of search techniques are not dependent on the type of an adaptive filter structure being employed. These techniques are capable of fast converging on to a global solution for any optimization problem. This makes the technique useful for optimizing both nonlinear as well as IIR adaptive filters. The authors had analysed that ADAPTIVE's had more controlled randomness than the use of Genetic Algorithms (GA). In ADAPTIVE, particles can take the directed steps within a well-defined region while in case of GA's particle updates are much less directed and are also more redundant. This affects the rate of Convergence of Genetic Algorithm. The authors had concluded that ADAPTIVE algorithm can also eliminate search redundancy by retaining the previous best and velocity values. Also in ADAPTIVE search is more readily controlled by using acceleration coefficients. So, the rate of convergence of ADAPTIVE can be tuned much faster than that of GA even with space of increased dimensionality. This makes ADAPTIVE better suited for many on-line adaptive filtering applications. Hyung G. Myung in [2] gave an overview of SC-FDMA based system. The authors explained the complete SC-FDMA process. It gave a detail insight of the different techniques used by SCFDMA transmitter and receiver. The author gave PAPR characteristics of SCFDMA based system and also channel dependent resource scheduling scheme of SC-FDMA system.

Meili Zhou et al. in [3] proposed a channel estimation technique based on spline interpolation. Further to improve performance of estimation process extendible inverse Discrete Cosine Transform (EIDCT) and DCT/EIDCT approach was suggested. In this process, Discrete Cosine Transform of the signal is performed and then least square (LS) and linear minimal mean square error (MMSE) is derived in DCT domain. Authors observed that performance of spline interpolation based estimation process decreases with increase in number of users. DCT/EIDCT based estimation process performs better than spline interpolator in terms of MMSE providing a gain of 7 to 10dB for two users and a gain of 5 to 8 dB for 8 users. Md. Masud Rana et al. in [4] described different sub-carrier mapping schemes like IFDMA (Interleaved FDMA) and LFDMA (Localised FDMA) for LTE-SCFDMA systems. Through simulations the author had proved that IFDMA sub-carrier mapping scheme provides lower PAPR as compared to LFDMA by a level of 1dB. Further the authors had shown that IFDMA sub-carrier mapping scheme improves system performance significantly as compared to LFDMA mapping scheme. Shih-Chan Huang et al. in [5] proposed a channel estimation technique for SCFDMA system operating over time-varying multipath channels. The proposed method utilized block-type pilot arrangement and needed no prior knowledge about channel statistics. Authors used sliding windowing technique so as to mitigate the effect of interferences effectively. The proposed method works effectively at low SNRs to achieve perfect channel estimation but performance degrades at high SNR with long window length. Md. Masud Rana et al. in [6] proposed an adaptive algorithm for estimation of channel impulse response from block of received data in SCFDMA system. Algorithm works without any prior knowledge of the channel. Authors had developed variable step size – Least mean square algorithm for channel estimation which can adapt the weighting coefficients to optimum value in accordance with channel conditions. The algorithm is updated on each iteration so as to minimize the error. The algorithm converges towards the true channel coefficient. Further author compared the proposed algorithm with exiting algorithm and had proved that the proposed algorithm outperform the existing algorithm by about 3dB. Md. Masud Rana et al. in [7] had presented a new channel estimator for an OFDMA system to avoid the least square (LS) problem. This proposed channel estimation method used knowledge of channel properties so as to estimate the transfer function of an unknown channel at non-pilot sub-carriers. This proposed method also reduces the computational complexity of the system. Sosth`ene Yameogo et al. in [8] presented a new channel estimation technique based on adding signal method. The channel subcarriers are estimated without using any interpolation techniques. The hidden signal is added in the useful signal band. The statistical properties of hidden signal permitted retrieval of channel information under the assumption that channel characteristics remain static over a long interval of communication duration so as to ensure fast convergence of the algorithm. This resulted into a better value for Symbol Error Rate and gain. Nik Ahmad et al. in [9] discussed that for designing a system, filters are required. The parameters of a filter can be varied. The calculation of filter parameters using transfer function is difficult for filters having high order as in that case more coefficients need to be estimated. The authors had presented an application of ADAPTIVE algorithm for designing parameter of high order filter. The authors applied ADAPTIVE algorithm to a six order filter. Henrik Sahlin et al. in [10] proposed a Discrete fourier transform (DFT) based channel estimation algorithm. Author used IDFT for channel estimation in time domain and then transformed it back to frequency domain using DFT. DFT based channel estimation technique has problem of distortion in band edges which leads to biased channel estimate. In order to overcome this problem authors had proposed to debias oversampled DFT channel estimates using digital Sinc function. Authors evaluated both DFT and DCT based channel estimation algorithms and had concluded that debiased oversampled DFT based channel estimation performed better than DCT based channel estimation process in MIMO LTE system.

III. PROPOSED METHODLOGY

The proposed work of system design will begin with understanding of present work on channel estimation techniques for SCFDMA system. This will include considering various parameters such as noise reduction, Bit Error Rate, Signal to Noise Ratio and average power of SC-FDMA system. The development of proposed system design for SC-FDMA system will include LMS based adaptive channel estimation technique so as to reduce error rate. The modulation schemes employed are BPSK, QPSK, and 16 QAM. The system design channel parameters will be optimized using ADAPTIVE or FPA and GWO. This technique is employed for optimization of parameters of weiner filter which is a part of Least Mean Square (LMS) channel estimation technique.

The methodology adopted in the proposed work is shown in the form of flowchart in fig.

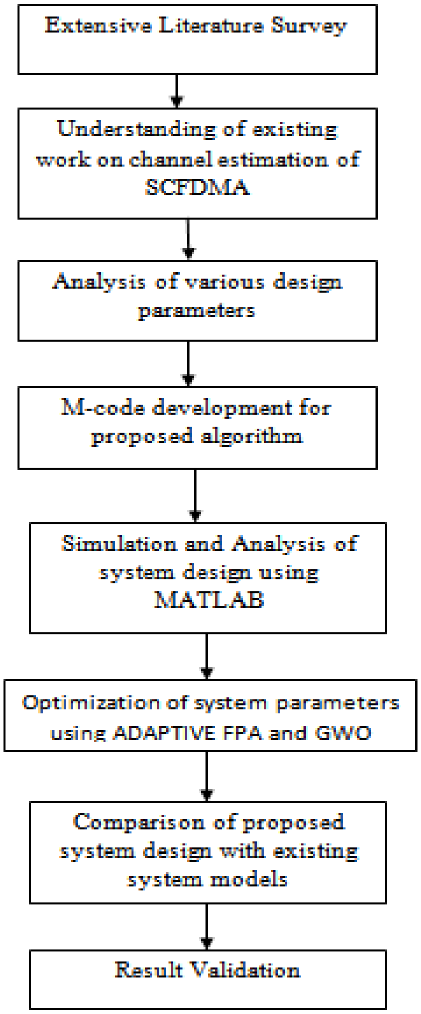

Fig. 1.2 Design methodology for proposed system

IV. RESULTS

This section gives simulation graphs and comparison between various channel estimation techniques like Linear Mean Square (LMS), Normalized-linear Mean Square (NLMS) and proposed channel estimation technique using LMS and ADAPTIVE for optimization

Grey Wolf Optimization: It is a meta-heuristic algorithm which simulates the leadership hierarchy and hunting behavior of wolves. The fitness of the wolves measured in the form of alpha, beta and delta. The figure 1.3 given below shows the hierarchy level of the wolves.

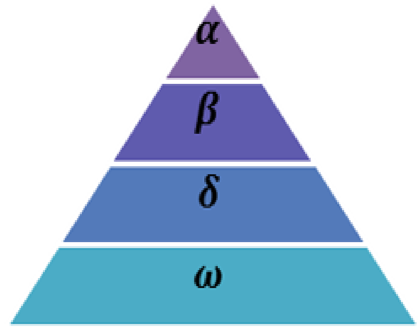

Fig. 1.3 Hierarchy level of Wolves

Grey wolves have the ability of memorizing the prey position and encircling them. The alpha as a leader performs in the hunt. For simulating of the behavior of grey wolves hunting in the mathematical model, assuming the alpha (α) is the best solution. The second optimal solution is beta (β) and the third optimal solution is delta (δ). Omega (ω) is assumed to be the candidate solutions. Alpha, beta and delta guides the hunting while position is updated by the omega wolves by these three best solutions considerations [11].

Encircling prey

Prey encircled by the grey wolves during their hunt. Encircling behavior in the mathematical model, below equations is utilized [11].

$$\vec{A}(T+1) = \overrightarrow{A_P}(T) - \vec{X}.\vec{Z}$$

$$\vec{Z} = \left|\vec{Y}.\overrightarrow{A_P}(T) - \vec{A}(T)\right|$$

Where

$\vec{Z}$ *and* $\bar{X}$ *are vectors that are*

calulated by above given equation.

T←iterative number

$\vec{A}$←grey wolf position

$\overrightarrow{A_P}$←prey position

$$\vec{X} = 2x.\vec{r_1} - x$$

$$\vec{Y} = 2\vec{r_2}$$

Where

$\vec{r_1}$and$\vec{r_2}$←random vector range[0,1]

The x value decrease from 2 to 0 over the iteration course.

$\vec{Y}\leftarrow$random value with range [0,1] and is used for providing random weights for defining prey attractiveness.

Hunting

For grey wolves hunting behavior simulation, assuming α, β, and δ have better knowledge about possible prey location. The three best solutions firstly and ω (other search agents) are forced for their position update in accordance to their best search agents position. Updating the wolve's positions as follows [11]:

$$\vec{A}(T+1) = \frac{\overrightarrow{A_1}+\overrightarrow{A_2}+\overrightarrow{A_3}}{3}$$

Where $\overrightarrow{A_1}, \overrightarrow{A_2}, and\ \overrightarrow{A_3}$ are determined,

$$\overrightarrow{A_1} = |\overrightarrow{A_\alpha} - \overrightarrow{X_1}.Z_\alpha|$$
$$\overrightarrow{A_2} = |\overrightarrow{A_\beta} - \overrightarrow{X_2}.Z_\beta|$$
$$\overrightarrow{A_3} = |\overrightarrow{A_\delta} - \overrightarrow{X_3}.Z_\delta|$$

Where $\overrightarrow{A_\alpha}, \overrightarrow{A_\beta}, and\ \overrightarrow{A_\delta}\leftarrow$ first three best solution at a given iterative T

Z_α, Z_β, and Z_ω are determined,

$$\overrightarrow{Z_\alpha} \leftarrow |\overrightarrow{Y_1}.\overrightarrow{A_\alpha} - \vec{A}|$$
$$\overrightarrow{Z_\beta} \leftarrow |\overrightarrow{Y_2}.\overrightarrow{A_\beta} - \vec{A}|$$
$$\overrightarrow{Z_\delta} \leftarrow |\overrightarrow{Y_3}.\overrightarrow{A_\delta} - \vec{A}|$$

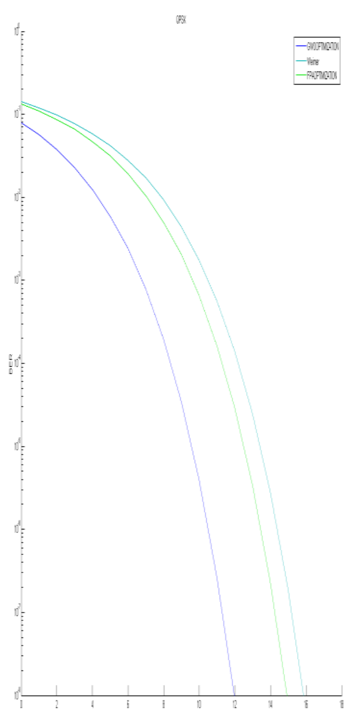

Figure 1.4: AWGN BPSK modulation:

In Figure 1.4 show the BPSK modulation on SCFDMA channel on AWGN noise. In this figure comparison between wiener filter and FPA optimize Adaptive Filter and GWO which optimize the prior of adaptive that's why it reduce the BER more than Weirner Filter.

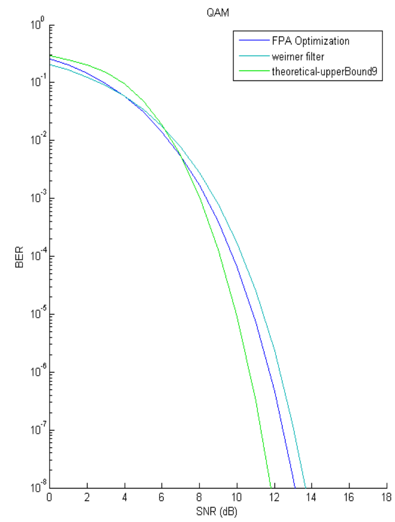

Figure 1.5: AWGN QPSK modulation:

In Figure 1.5 show the QAM modulation on SCFDMA channel on AWGN noise. This figure shows the comparison between wiener filter and FPA optimize Adaptive Filter and GWO Filter which optimize the prior of adaptive that's why reduce the BER more than Weirner Filter. But if we compare with Figure 1.4 and Figure 1.5 BPSK reduce BER but QAM increase SNR.

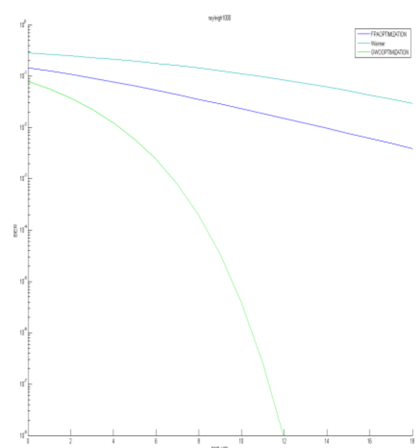

Figure 1.6: AWGN QAM

In Figure 1.6 show the QAM modulation on SCFDMA channel on AWGN noise. In this figure comparison between wiener filter, FPA optimize Adaptive Filter and GWO which optimize the prior of adaptive that's why reduce the BER more than Weirner Filter which performs better than QPSK and BPSK modulation.

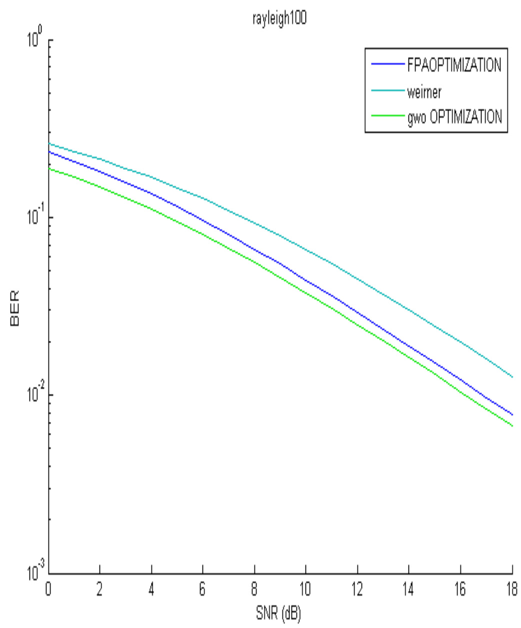

Figure 1.7: Rayleigh with 100

In Figure 1.7 show the SCFDMA channel on Rayleigh noise. In this figure comparison between wiener filter, FPA optimize Adaptive Filter and GWO which optimize the prior of adaptive that's why reduce the BER more than Werner Filter. But Rayleigh channel not significant increase performance of FPA because of Rayleigh channel highly variable noise.

V. CONCLUSION

An efficient design of channel estimation technique for SCFDMA system is presented and this design has been optimised using Flower Pollination Algorithm and Grey Wolf optimization. GWO optimized LMS channel estimation technique can estimate channel dynamics and support multiple access. In this scheme weighting coefficients are updated by the algorithm dynamically without any information regarding channel statistics. The signals while travelling through noise channel keep on fluctuating, these fluctuations are nullified using this algorithm. The given algorithm converges towards the accurate channel coefficients. This advantage of convergence of channel coefficients towards the true channel coefficient as well as BER performance could be of relevant use in future mobile communication.

VI. REFERENCES

[1]. D. J. Krusienski, W. K. Jenkins, "Adaptive Filtering Via Particle Swarm Optimization", IEEE 37th Asilomar Conference On Signals, Systems and Computers, vol.1, pp. 571-575, 2003.

[2]. Hyung G. Mung, "Introduction to single carrier FDMA", Proceeding of 15th European Signal Processing Conference, pp. 2144-2148, 2007.

[3]. Meili Zhou, Bin Jiang, Wen Zhong, Xiqi Gao, "Efficient Channel Estimation for LTE Uplink" IEEE, 2009.

[4]. Md. Masud Rana, Jinsang Kim, and Won-Kyung Cho, " Performance Analysis of Sub-carrier Mapping in LTE Uplink Systems" IEEE 9th International Conference on Optical Internet, pp 1-3, 2010.

[5]. Shih-Chan Huang, Jia-Chin Lin, Kao-Peng Chou, "Novel Channel Estimation Techniques on SC-FDMA Uplink Transmission" IEEE International coference,2010

[6]. Md. Masud Rana, Jinsang Kim, Won-Kyung Cho, "Blind Channel Estimation in LTE Uplink System Using Variable Step Size Based LMS Algorithm" IEEE International Conference on Optical Networks,2010.

[7]. Md. Masud Rana, Jinsang Kim and Won-Kyung Cho, "Low Complexity Downlink Channel Estimation for LTE Systems" IEEE International Conference on Advanced Communication Technology, Vol.2, pp. 1198-1202, 2010.

[8]. Sosth`ene Yameogo, Jacques Palicot, Laurent Cariou "Channel Estimation Technique by Hidden Signal: Application in the SC-FDMA Context" IEEE 6th International Conference on Wireless and Mobile Communications, pp. 38-41, 2010.

[9]. Nik Ahmad Nizam b. Nik Zainuddin, Ihsan M. Yassin, Azlee Zabidi, Hasliza Abu Hassan, "Optimizing Filter Parameters using Particle Swarm Optimization", 6th International Colloquium on Signal Processing & Its Applications, pp.9-14, 2010.

[10]. Henrik Sahlin, Anders Persson, "Aspects of MIMO Channel Estimation for LTE Uplink" IEEE conference, 2011

[11]. Liu, Haiqiang, et al. "An Intelligent Grey Wolf Optimizer Algorithm for Distributed Compressed Sensing." *Computational Intelligence and Neuroscience* 2018 (2018).