Novel Approach of Channel Estimation in OFDM with Rayleigh Channel Using Firefly Optimization

Shaveta[1], Mukta Sharma[2]
[12]*ECE, GGS College of modern technology, kharar, Punjab*

Abstract- Substitution to the problem employed OFDMA system for its uplink transmission. OFDMA 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 OFDMA 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 OFDMA 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 thesis optimize the Flower firefly algorithm analysis by BER (bit error rate) which reduce in optimization approach when increase the SNR.

Keywords- International Mobile Telecommunication, Orthogonal Frequency Division Multiple Access, Long term evolution, Peak-to-Average-Power Ratio.

I. INTRODUCTION

The wireless applications have now grown much rapidly. There is a demand of high quality as well as high speed of data in wireless communication applications [1]. To cater it, International Mobile Telecommunication (IMT) and 3rd Generation partnership project (3GPP) proposed LTE system. The features of LTE system are as under:

- To provide End-to-End quality service.
- To provide high download rates of about 300Mbps and upload rates of 75Mbps.
- To expand the capacity of cell so as to accommodate 200 active users.
- To support user mobility of around 350Km/hr.
- Orthogonal Frequency Division Multiple Access (OFDMA) used for downlink and Single Carrier-Frequency Division Multiple Access (SC-FDMA) for Uplink.
- Support for FDD and TDD Communication Systems.
- Increased Spectrum Flexibility (1.4 MHz, 3MHz, 5MHz, 10 MHz, 15MHz, 20MHz)

So as to provide these features, 3GPP Long Term Evolution system has adopted OFDMA for its down link transmission and SC-FDMA for its Uplink transmission as multiple access techniques. OFDM is a powerful and efficient modulation technique employed in wireless communication systems. OFDM uses orthogonal subcarriers to convey information to the receiver. OFDMA or Orthogonal Frequency Division Multiple Access is an OFDM based scheme which enables multiple users to access the channel simultaneously. OFDMA is preferred as it provides high data rate and can eliminate the problem of Inter Symbol Interference (ISI). It utilises spectrum efficientlyand also provides robustness towards various multipath fading phenomenon. An important issue of an OFDMA based system is its transmitted signal Peak-to-Average- Power Ratio (PAPR). In OFDMA superposition of many time-domain data subcarriers results in high values of PAPR. As large numbers of subcarriers are employed during transmission, this results in a time-domain signal exhibiting a Rayleigh characteristics and large amplitude variations in time domain. These large peaks of signal require power amplifiers of high power. The increase in the level of the signal causes various nonlinear distortions which leads to inefficient operation of power amplifiers. So, OFDMA has a disadvantage of high PAPR which causes increase in the size of user terminal and thus causes increase in overall cost of the system. In Long term evolution (LTE) system OFDMA is adopted only for downlink transmission because base stations called eNodeB can transmit on high power. As a substitution to the problem of PAPR, 3GPP LTE had employed OFDMA system for its uplink transmission. OFDMA 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).

A. OFDMA systems: 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 [2, 3]. 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 [3]. 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. Fig.1 gives block diagram representation of an OFDM system:

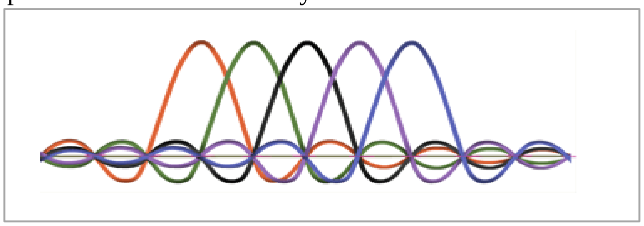

Fig.1: OFDM Spectrum

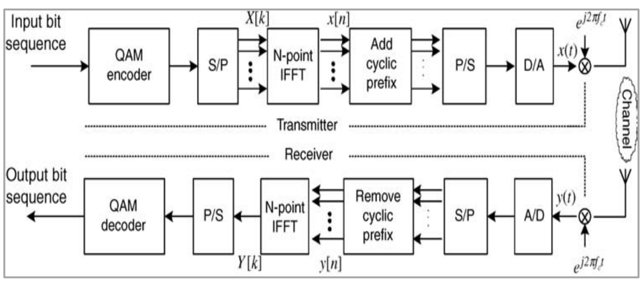

Fig.2: Block diagram representation of transmitter & receiver in OFDM system

At OFDM transmitter, message bits are mapped into sequence of modulated symbols using QAM or PSK modulation technique. This serial data is then converted into parallel data stream using serial-to-parallel converter. This parallel data stream is then divided among N differentparallel paths after employing N-point Inverse Fast Fourier Transform (IFFT). Each of the orthogonal sub-carrier signals is modulated by any one of the *N* data sets. These Nprocessed points form one OFDM symbol. Due to this conversion process, the transmission time interval (TTI) for N different symbols becomes NT_s, where T_s is the interval of single symbol. After this a copy of last L of the samples of one symbol are copied onto the front as a cyclic prefix. This data is then converted into serial data stream using parallel to serial conversion process [4]. At the end after this process a digital-to- analog conversion is employed. At receiver to recover back the original information a reverse process is carried out. Firstly, the received analog signal is converted into digital signals. This digital signal is then converted into parallel form using serial to parallel conversion process. The CP added to the signal at transmission end is then removed. A N-Point FFT will be conducted on the left over samples to recover back the frequency domain data. This data in frequency domain is converted into serial format and converted back into original data by employing a decoder.

B. ***Advantages of OFDM system:*** Some of the advantages of the system are listed below:

- High data rates
- High spectral efficiency
- Provides robustness to different multipath fading effects
- Low complexity
- Robustness to inter-symbol interference
- No use of very expensive equalisers
- Spatial diversity
- Multiplexing gains
- High rates of data transmission over multipath fading channels
- Increased link capacity

C. ***Drawbacks of OFDM system:*** OFDM Gaussian distributed signals have large Peak-to-Average Power Ratio causing:

- Poor power efficiency
- Spectral re-growth
- Sensitive to nonlinear effects of power amplifiers
- OFDM signal being clipped by high power amplifiers
- Degradation in system performance due to In-band distortion
- Adjacent channel interference due to out-band radiation

D. PAPR

In OFDM large variations in the envelope of transmitted signal is due to the transmission of data over several parallel subcarriers which could add in phase and generate a signal with high instantaneous peak power compared to the average power of signal [5].The Peak to Average Power ratio of a signal is defined as the ratio of maximum power of pass band signal to the average power of signal.

$$PAPR = P_{peak} / P_{average} \quad \text{...........................} \ (1.1)$$

PAPR of a signal vector $\mathbf{x}_n = x_0, x_1, \ldots x_{N-1}$ is given as follows:

$$PAPR(x) = \frac{\max\left\{\left|x_n\right|^2\right\}}{E\left\{\left|x_n\right|^2\right\}}, 0 \le n < N-1 \quad \text{.............} \ (1.2)$$

Where, E {.} is expectation operator.The high value of PAPR in OFDM based communication system requires highly linear power amplifiers to avoid excessive inter modulation distortion. The power amplifier is required to operate with large back off from its peak value. So the power amplifier has low power efficiency. These high peak signals can also get clipped by high power amplifiers. This degrades system performance due to In-band distortion and causes adjacent channel interference due to out-band radiation. Large value of PAPR requires that user terminal (UE) should be able to handle large power which increases size of UE.Because of various disadvantages associated with high PAPR of OFDM signals, it is to be reduced [6]. The performance of any PAPR-reduction technique in effectively reducing PAPR is evaluated in terms of its complementary cumulative distribution function (CCDF). CCDF is defined as the probability that PAPR exceeds a certain threshold value $PAPR_0>0$, i.e.

$CCDFx_n \quad PAPR_0 = Prob PAPRx_n > PAPR_0$………………….. (1.3)

CCDF of OFDM signal is calculated as:

$CCDF(Y) = Pr(PAPR > Y) = 1 - Pr(PAPR < Y)$……. (1.4)

E. PAPR Reduction Techniques:Different PAPR reduction techniques can be classified into following approaches:

*1) Clipping techniques:*The clipping technique is one which employs clipping of the peaks of the signal so as to reduce its PAPR. This technique is really simple to implement but it has disadvantage of in-band and out-of-band interferences which can destroy the orthogonality among sub-carriers. This PAPR reduction technique also requires additional methods for signal processing so as to reconstruct the received signals [6].

*2) Coding techniques:*Coding techniques select few code words that can minimize the PAPR of a signal. Coding techniques suffers from the disadvantage of poor bandwidth efficiency as we reduce code rate. This technique comprises of the complexity of finding the best code words and it also has to store a large number of lookup tables required for encoding and decoding of data.

*3) Probabilistic or scrambling techniques:*The probabilistic technique scrambles a block of input OFDM symbols and then transmits only one of them having minimum value of PAPR. This reduces the probability of achieving high PAPR. This method does not have problem of out-of-band power [7]. But it has reduced spectrum efficiency also the complexity of system increases with an increase in the number of subcarriers employed.But this technique does not offer PAPR below a certain specified level.

4) Adaptive pre-distortion technique: This technique compensate for various nonlinear effects of high power amplifiers (HPA) employed in an OFDM system. It can really work with the time variations of nonlinear amplifiers by modifying the constellation of input by using Memory lookup encoder and requires least hardware.

*5) DFT-spreading technique:*The DFT-spreading technique employs Discrete Fourier Transform technique to spread the input signal spectrum. This technique can cause reduction in the PAPR level of OFDM system to a level of communication system employing single-carrier only. This technique is employed for transmission. It is also called Single Carrier-FDMA (SC-FDMA).

F. SC-FDMA

Single carrier frequency division multiple accesses is a multiple access technique employed for transmitting signal in uplink and is employed in 3rd generation partnership project (3GPP) Long Term Evolution system. SC-FDMA is basically linearly pre-coded OFDMA.SC-FDMA signal is basically an OFDM signal in which data symbols in time-domain are transformed into frequency-domain by using discrete Fourier transform process [8].

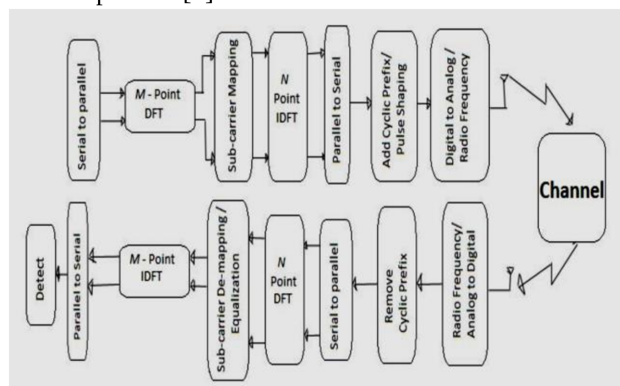

Fig.3: Block Diagram representation of SC-FDMA transmitter and receiver

At the OFDMA transmitter, a baseband modulator maps the input bits stream into a sequence of complex numbers by using various modulation techniques like BPSK, QPSK, 16QAM, 64QAM etc. After this, the transmitter will group the modulation symbols into blocks which contain Ndifferent symbols. The transmitter then performs *N*-point DFT operation to convert signal into its frequency domain representation. The transmitter than maps each of its outputN-DFT to any one of the *M* (>*N*) different orthogonal sub-carrier signal. An M-point IDFT operation then transforms these subcarrier amplitudes into a time domain signal.

Three different sub carrier mapping techniques are employed:

1) Distributed subcarrier mapping: In this mode, N different DFT output signal are distributed over the entire bandwidth of the system. This is known as distributed FDMA or DFDMA.

2) Localized subcarrier mapping: In this mode, outputs of DFT block are assigned to N consecutive subcarriers with total M numbers of subcarriers (M>N) available. This is called Localized FDMA or LFDMA.

3) Interleaved subcarrier mapping: In this mode, the DFT outputs are distributed employing an equal distance between the occupied

subcarriers. This is called Interleaved FDMA or IFDMA. In IFDMA output is allocated over the entire system bandwidth. OFDMA transmitter also performs the operation of adding cyclic prefix. It inserts a set of symbols so as to provide a guard time. C P is a copy of the last part of the symbol block and is added to the start of each block. This addition of CP prevents inter-block interference (IBI) which is caused by multipath propagation. The SC-FDMA transmitter also performs operation of linear filtering called pulse shaping so as to reduce out-of-band signal energy.The OFDMA receiver transforms its received signal back into its representation in frequency domain by using DFT technique. It then de-maps the subcarriers signals and perform its frequency domain equalization.

G. Advantages of SC-FDMA system

- It provides robustness against multipath signal propagation.
- Low PAPR as compared to OFDMA due to use of single carrier structure.
- High rate of data transmission.
- Uses power amplifier more efficiently, so LTE terminals are able to increase coverage and reduce their power consumption, which is extremely important in battery powered devices.
- As each user is assigned different set of orthogonal subcarriers so there is no Multiple Access Interference.
- Power efficient system.
- Increased coverage area of the System.
- Allows use of small size terminal.

Because of these advantages of OFDMA system over OFDMA system, OFDMA system is employed for uplink communication in 3GPP Long term evolution (LTE) system.

H. Channel Estimation

In order to achieve good performance a communication receiver needs to know the impact of channel on received signal. This is called channel estimation. An important factor for any wireless communication system is estimation of its channel and channel parameters. The motive of a channel estimation process is to minimize Mean Squared Error (MSE) between desired signal and received signal. Different channel estimation algorithm had been designed so as to achieve high performance. Using channel estimation algorithm impulse response of a channel and its behavior can be approximated. By employing channel estimation techniques, coherent demodulation technique can be implemented at the receiver [8]. In communication system for channel estimation a known signal sequence called pilot signals are inserted at specific location within the information signal. These symbol sequences allow receiver to extract channel attenuations and phase rotation estimates for each received symbol. By identifying channel parameters error in the received signal can be reduced. The aim of most channel estimation algorithms is to minimize the mean squared error (MSE), while utilizing little computational resources in the estimation process. Fig.4 gives block diagram of system using channel estimation.

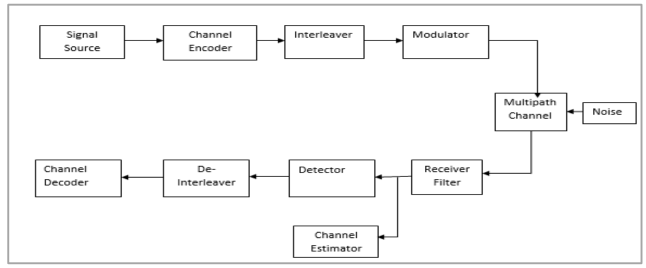

Fig.4: Block Diagram of a system using Channel Estimation

Different Channel estimation techniques are:

1) Pilot based channel estimation technique: Pilot or Training based estimation method exploit presence of known training symbol. These channel estimation techniques either uses deterministic or random parameters. Using deterministic parameters there are following channel estimation techniques:

- Maximum Likelihood (ML) estimator
- Least Square (LS) estimator
- Normal Least Square (NLS) estimator
- DFT based LS estimator

2) Estimation techniques based on random variables are:

- Minimum Mean Square Error (MMSE)
- Linear Minimum Mean Square Error (LMMSE)
- Max a Posterori (MAP)

I. ***Adaptive channel Estimation:*** Adaptive channel estimation is a process of self-modifying coefficients of digital filtration process to minimize the error function of filter. The error function is defined as a distance between its desiredsignal and the output of an adaptive filter [9]. The adaptive filters are employed for noise and echo cancelling, channel equalization, signal prediction, etc. The basic block representation of an adaptive filtration process is given in Fig.5 below:

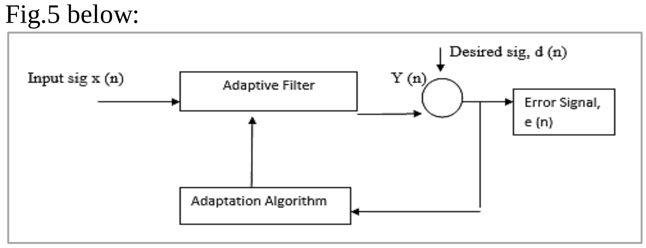

Fig.5: Basic representation of Adaptive Filters

Where the error function is represented as:

$$e(n)=d(n)-y(n) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1.5)$$

Where, x(n) is the input signal,d(n) is desired output signal and, $y(n)$ is an output of adaptive filter

This error signal e (n) is used by an adaptation algorithm so as to update its coefficient vector **w** (n) according to some defined performance criterion. The adaptive channel estimation is different from traditional methods as the coefficients of an adaptive filter can change over time. So they have self-learning ability. Adaptive filters can accomplish certain processing tasks that traditional digital filters cannot perform. Adaptive filters can complete certain real-time or online modeling tasks which traditional digital filters cannot. The channel estimation can be done by using wiener filter. Wiener filters are basically linear filters which can perform estimation of a desired signal sequence linearly from other related sequences. A Wiener filter is a Mean Square Error optimal linear filter employed for signals which are degraded by additive noise [10, 11]. An advantage of using wiener filter for filtering operations is that it has prior knowledge of channel parameters. The wiener filter design is given below:

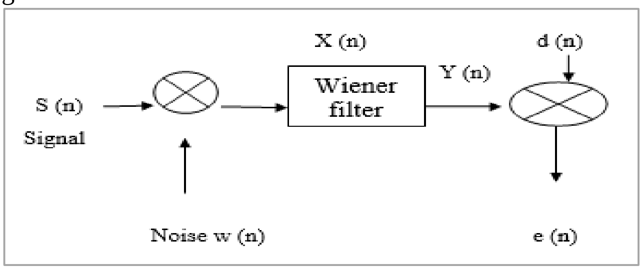

Fig.6: Channel Estimation using Wiener Filter

In this diagram, an error signal generated by filter is used by an adaptation algorithm to update its coefficient vector h(n) according to some defined performance criterion. This complete adaptation process minimizes error signal and also it forces the adaptive filter output signal to approximate the reference signal. In communications systems, the transmitted signal is heavily distorted by the characteristics of transmission channel [11]. The original signal can then be recovered l by employing an adaptive filter. A training sequence *s*(n) which is known to the receiver is sent via a given transmission channel which generates a distorted signal. Sequence *s*(n), after time shift in accordance with transmission delays is used as a reference signal in the receiver for the adaptive filtering process. When the error function e(n) becomes zero, the output signal *y*(n) will then represent the transmitted signal *s*(*n*). This indicates that the adaptive filter is compensating for any channel distortions. After this training process, all desired information can be sent through the channel. This adaptation of the filter coefficients generally follows a minimization procedure for an objective.

Output y(n) of the filter is given as:

$y(n)=\sum_{k=0}^{p-1} \square(k) * x(n-k)$ ……………… (1.6)

The Mean Square Error is represented as:

$MSE=E[|d(n)-y(n)|^2]$……………………….. (1.7)

The value of vector, w which minimizes the MSE is defined by finding derivative of above equation w.r.t each w_i and is given by wiener-hopf equations which form basis of wiener filter:

$R_x H^0=P_{dx}$……………………………………. (1.8)

Using this channel estimation is made as

$H^0=R_x^{-1}P_{dx}$ ……………………………….. (1.9)

Where,

R_x is the autocorrelation matrix of an input sequence x(n) and is

$R_x=E[x(k)x^T(k)]$ …………………………… (1.10)

P_{dx} is a Cross-Correlation matrix between input sequence x(n) and desired response y(n) and is given by

$P_{dx}=E[y(k)x^T(k)]$…………………………….. (1.11)

H^0 is called Wiener solution for minimizing MSE.

II. RELATED WORK

GauravMathur et al. in [1] had compared performance for different subcarrier mapping schemes in MIMO- OFDMA system using STBC (Space Time Block Code).The authors had compared Bit Error Rate performance for different number of transmitters. In STBC, spatial diversity technique signals are coded through the transmit antenna which creates redundancy and thus reduces outage probability. The authors had shown that IFDMA is better than LFDMA in terms of Bit Error Rate.Sanjana T et al. in [2] discussed the problem of distortion in communication system which are caused by fading, delay spread and multipath effect. The authors had designed various channel estimation and equalization techniques to provide improvement in performance of an OFDM based system. The authors had proposed the use of wiener filter for channel estimation. The simulation results of the proposed designs show that wiener filter provides better channel estimation. Also OFDM performs better under AWGN channel than fading channels. The authors conclude by plotting SER curves that wiener performs better in AWGN than fading channels and achieve better SER. Hyun-Myun Kim et al. in [3] had investigated channel estimation technique for MIMO SC-FDMA systems in frequency domain. The authors developed channel estimation error model for by employing code division multiplexed (CDM) pilot – cyclic shifted Zadoff Chu sequences. Authors compared performance of Cascaded one dimensional (CID) robust MMSE (Minimum mean square error) technique and two dimensional MMSE techniques. In this paper, authors proposed a Robust Iterative Channel Estimation (RITCE) process with frequency replacement algorithm to improve performance of CID RMMSE. After deriving MSE of iterative channel estimation, FR algorithm is optimized. CID RITCE technique has complexity higher than CID RMMSE but provides improved performance without any error propagation. Qiang Li et al. in [4] demonstrated a channel estimation technique for MU-MIMO LTE system based on DFT which can also restore the orthogonality in inter-layer. The authors had shown that energy leakage in channel impulse response affect performance of channel estimation process. The proposed method generated a virtual time domain shift to the estimated channel impulse response of each layer. This reduced leakage to other samples. This VTA-DFT based technique performed better than direct-DFT and windowed-DFT. It provided performance gain of about 2dB.The proposed technique provided near accurate channel estimation.Dan Li et al. in [5] proposed a fast time-varying channel estimation method for SC-FDMA system in frequency domain. As the fast variations of the SC-FDMA channel characteristics causes Inter-Carrier Interference. The authors had proposed an estimation technique which by performing in the frequency domain can estimate only a part of the channel frequency response for each of uplink user. The proposed method can be employed with system having user mobility lower than 350Km/hr. Yongkui Ma et al. in [6] had presented channel estimation technique for OFDMA system. The estimators proposed by authors are based on Normalized Least Mean Square (NLMS) and Recursive Least Square (RLS) algorithms. Authors had compared performance of non-adaptive wiener filter based estimators with proposed adaptive estimation algorithm. Authors had concluded that adaptive estimation techniques do not require static prior knowledge and has reduced computational complexity NLMS and RLS estimators update coefficients continually and do not need prior knowledge. The performance and convergence of these adaptive estimators is affected by Doppler frequency shift, filter length and SNR.SomaUmamaheshwarb et al. in [7] had proposed a detection technique for estimating channel parameters when the signal is corrupted with non-Gaussian noise signal. The authors had proposed a new M-estimator based clustering technique. These M-estimators will try to reduce the effect of noise by replacing the squared residuals by less rapidly increasing function of the residuals. This new M-estimator uses k-means clustering algorithm. The authors had compared the performance of proposed algorithm with the Least Squares, Huber and Hampel based detectors in a Rayleigh fading environment which are corrupted with non-Gaussian noise. **Hua Zhang et.al. [8]** This letter considers a direct current-one-sided optical orthogonal frequency division multiplexing (DCO-OFDM) with intensity-modulated direct-detection (IM/DD) regulation for visible light communication (VLC) frameworks. The high peak-to-average power ratio (PAPR) is a basic execution restricting factor for the DCO-OFDM framework. To decrease the PAPR, exhibit a PAPR decrease strategy by applying semi-unequivocal unwinding way to deal with Tone Injection (TI). With the proposed strategy, accomplish a noteworthy PAPR decrease as extensive as 5 dB, which adds to a discernible BER execution pick up as prove by reenactment comes about considering the light transmitting diode (LED) nonlinearities.**Chen Ye et.al. [9]** In this paper, a novel segmental partial transmit sequence (S-PTS) plot is proposed for the peak-to-average power ratio (PAPR) decrease in counterbalance quadrature plentifulness balance based orthogonal frequency-division multiplexing (OQAM-OFDM) frameworks. The key thought of the S-PTS plot is to isolate the covered OQAM-OFDM signals into a number of sections, and afterward some disjoint sub-blocks are separated and increased with various stage pivot factors in each portion. Contrasted and the regular PTS conspire straightforwardly utilized in OQAM-OFDM systems, the S-PTS plan could offer better PAPR diminishment with bring down computational unpredictability.**Li Li et.al. [10]** In this paper, they plan an optimization issue to make strides the joint decoding execution by improving the partition. Moreover, two avaricious based calculations are proposed to settle the issue. Recreation comes about demonstrate that the joint decoding scheme with the proposed partition calculations gives acceptable blunder rectifying execution for a bigger number of PTS gatherings, than it does with the pseudo-random partition. With the enhanced execution, better PAPR execution can be bolstered.**JinweiJi et.al. [11]** Proposed a straightforward and flexible peak-to-average power ratio (PAPR) reduction plot for coded single carrier frequency division multiple access (SC-FDMA) signals in the uplink of the Long Term Evolution (LTE). The proposed plot depends on the acquaintance of few bit errors with adjust the few complex regulated images of every information SC-FDMA image in a sub-outline, which cause peaks of the yield signal examples to be bigger than a predetermined limit esteem. Likewise, the impact on the bit error rate (BER) execution of the few deliberately adulterated bits can be extraordinarily relieved by utilizing the channel translating at the collector. PC reproductions appear that the proposed plan can diminish the PAPR of SC-FDMA signals adequately with nearly an indistinguishable BER from the ordinary SC-FDMA signals when the signal-to-noise ratio (SNR) is underneath 35 dB.

III. THE PROPOSED METHOD

In this section, we discussed the proposed approach and the methodology used to achieve the results.

A. Proposed methodology:Flowchart

The proposed work of system design will begin with understanding of present work on channel estimation techniques for OFDM system. This will include considering various parameters such as noise reduction, Bit Error Rate, Signal to Noise

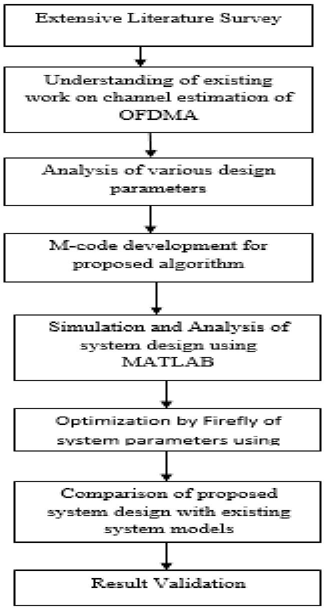

Fig.7: Proposed Flowchart

Ratio and average power of OFDM system. The development of proposed system design for OFDM system will include LMS based adaptive channel estimation technique so as to reduce error rate. The modulation schemes employed are BPSK, QPSK, 16QAM. The system design channel parameters will be optimized using ADAPTIVE or Particle swarm optimization technique. This technique is employed for optimization of parameters of weiner filter which is a part of Least Mean Square (LMS) channel estimation technique. The simulation and analysis of system design will be carried out in MATLAB environment. The methodology adopted in the proposed work is shown in the form of flowchart in fig.7 shown above.

B.Design of Proposed System

The proposed system simulation consists of three parts:

1. Transmitter system
2. Channel
3. Receiver system

The block diagram in the fig shows design of proposed system

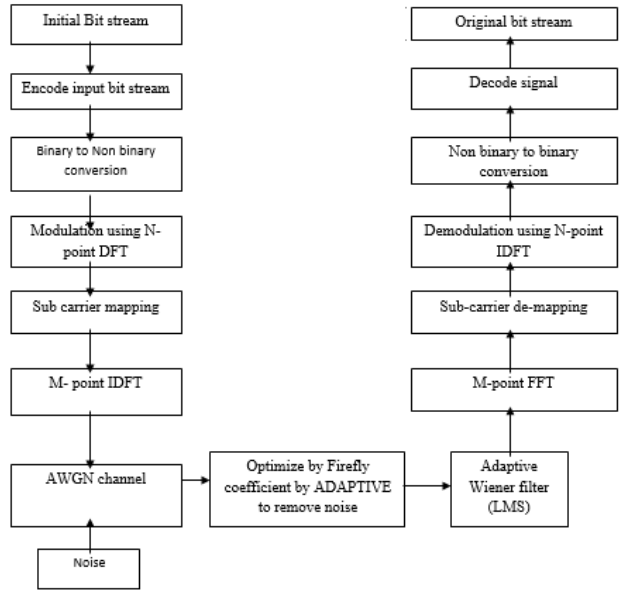

Fig.8: Block diagram of proposed system

Adaptive Channel Estimation: The assumptions made for channel estimation algorithm are given below in Table.1

Table.1 Simulation parameters for channel estimation

Algorithm parameter	Assumption	Channel Estimation Algorithm
H	6.04*e-6	Adaptive
w_{est}	H	
No. of iterations	300	
H	6.06*e-7	Existing
w_{est}	η_{max}	
No. of iterations	300	
H	6.04*e-7	Proposed
w_{est}	η_{min}	
No. of iterations	300	

The flow chart for channel estimation process shows the steps taken for adaptive channel estimation. In OFDMA system, channel adds noise to the transmitted signal. The characteristic of this channel noise is predicted by using LMS technique. At the receiver end of channel, the signal is received from the selected channel. At the receiver various signal processing techniques like removing cyclic prefix, subcarrier demapping, parallel to serial conversion, IFFT etc are carried out. The parameters of wiener filter are initialized. An error signal is generated in accordance with the difference between the processed receiver output and the output of wiener filter. If there is no error between filter output and received signal, then estimated filter parameters are stored. In case of error, filter weights are updated using LMS algorithm and these values of parameters are optimized using ADAPTIVE. As soon as the error reaches zero, the filter weights are stores as optimized values of channel parameters and the algorithm terminates.The complete process of channel estimation is shown in the form of flow chart in fig.8

The flow chart of adaptive channel estimation is given below:

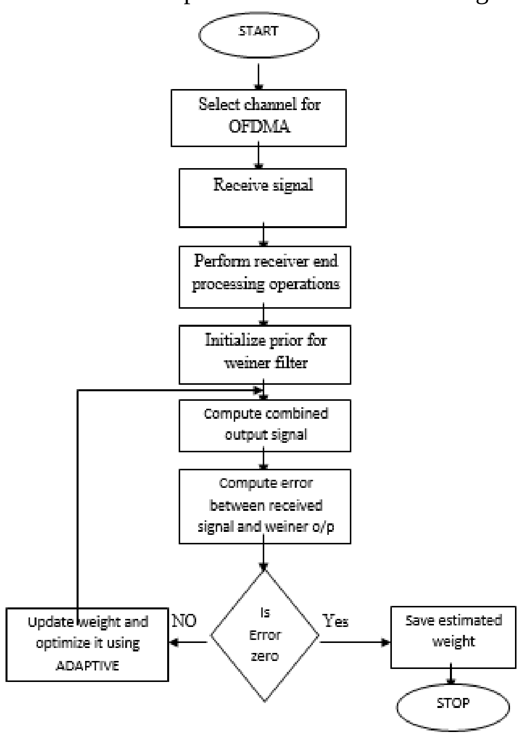

Fig.9: Flow chart for adaptive channel estimation

B. Description of the Algorithms Used: The following is the detail of the different algorithms used in the present work.

1. Firefly optimization algorithm (FOA): The biological objective of flower firefly is to optimally reproduce a new enormous generations of the flower kind with the fittest features that ensure the kind`s survival. In order to ideally formalize the flower firefly algorithm, characteristics of firefly process, flower constancy and pollinator behavior should be approximated based on the following essential rules:

- Global firefly achieved by L'evy's flights` travelling pollinators for both biotic and cross-firefly.
- Local firefly achieved abiotic and self-firefly.
- The new generation reproduction probability depends on the flower consistency and proportional to flowers` similarities/differences.
- The switch probability p ∈ [0, 1] controls the shift between local and global firefly.

The simple flower firefly model assume that each plant has only one flower, and each flower only produce one pollen gamete. Thus, there is no need to distinguish a pollen gamete, a flower, a plant or solution to a problem.

2. 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 Fig.6 given below shows the hierarchy level of the 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 the grey wolves hunting behavior 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 should be updated by the omega wolves by these three best solutions considerations.

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

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

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

Where

T←iterative number

$\vec{A}$←grey wolf position

$\overrightarrow{A_P}$←prey position

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

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

Where

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

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

$\vec{Y}$←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 wolves' positions as follows:

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

(1)

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

$$\overrightarrow{A_1} = \left|\overrightarrow{A_\alpha} - \overrightarrow{X_1}.Z_\alpha\right|$$

$$\overrightarrow{A_2} = \left|\overrightarrow{A_\beta} - \overrightarrow{X_2}.Z_\beta\right|$$

$$\overrightarrow{A_3} = \left|\overrightarrow{A_\delta} - \overrightarrow{X_3}.Z_\delta\right|$$

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,

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

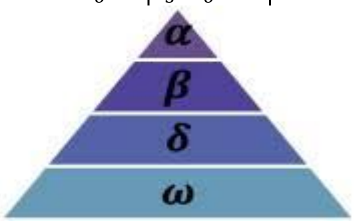

Fig.10: Hierarchy levels of the wolves

.

1) The first level wolver are called are alpha wolves. They are dominant in nature and all the wolves followed their orders. They are the best decision makers and having the best fitness value in the whole pack. They are also the leaders of the pack.
2) The Second level wolves are the beta wolves and also called as subordinate wolves which help in decision making in alpha and also the other members of the pack.
3) The third level wolves are the delta wolves they work after the beta wolves. They are considered when the beta wolves are not working properly. These wolves are also called as scouts.
The fourth and the last level of the hierarchy are related to the omega wolves. Omega wolves have low fitness value.

IV. RESULTS

A. Proposed Simulation Environment: The simulation of proposed design algorithm is carried out in MATLAB 12 environment. The parameters considered for simulation of design are given below in the form of table1 below:

Table.2 System Simulation Parameters

Parameters	Assumptions
Modulation	QPSK, BPSK QAM
Carrier Frequency	16GHZ
Bandwidth	512Kbyte
FFT size	1024 bits
Cyclic Prefix	5 block
Subcarrier mapping	Interleaved OFDMA
Relative Velocity	120Km/hr
IFFT size	1024 bits

B. Proposed system Simulation

Global firefly:

$$x_i^{t+1} = x_i^t + (x_i^t + g^*)$$

g^*= current best solution
L= length of the firefly
x_i^t= a solution in the present optimization problem

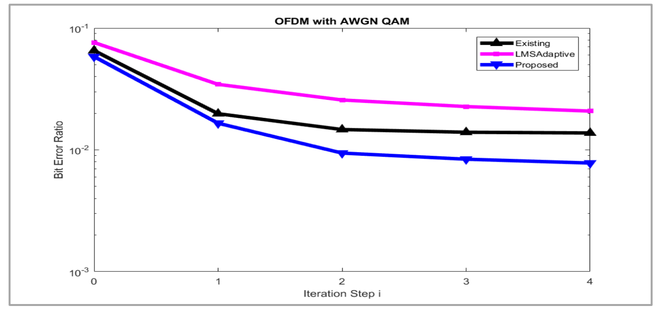

Fig.11: Bit error rate comparison in AWGN with modulation

In Fig.11 show the BPSK modulation on OFDMA channel on AWGN noise. In this figure comparison between wiener filter and Existing optimize Adaptive Filter which optimize the prior of adaptive that's why it reduce the BER more than Weirner Filter.

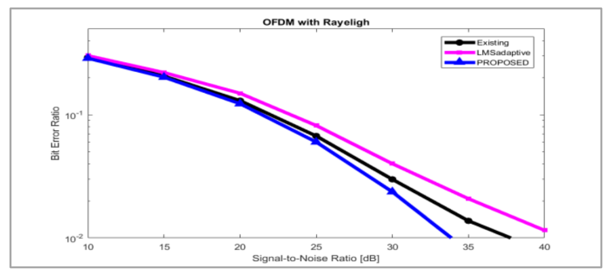

Fig.12: Bit error rate comparison in Rayleigh:

In Fig.12 show the QAM modulation on OFDMA channel on rayeligh noise. This figure shows the comparison between wiener filter and Existing optimize Adaptive Filter which optimize the prior of adaptive that's why reduce the BER more than Weirner Filter. But if we compare with Figure 4.1 and Figure 4.2 BPSK reduce BER but QAM increase SNR.

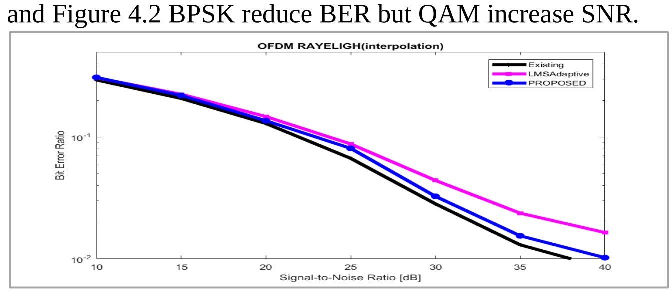

Fig.13: Bit error rate comparison in Rayleigh with Interpolation

In Fig.13 show the QAM modulation on OFDMA channel on Rayeligh noise. In this figure comparison between wiener filter, Existing optimize Adaptive Filter and PROPOSED which optimize the prior of adaptive that's why reduce the BER more thanWeirner Filter which performs better than QPSK and BPSK modulation

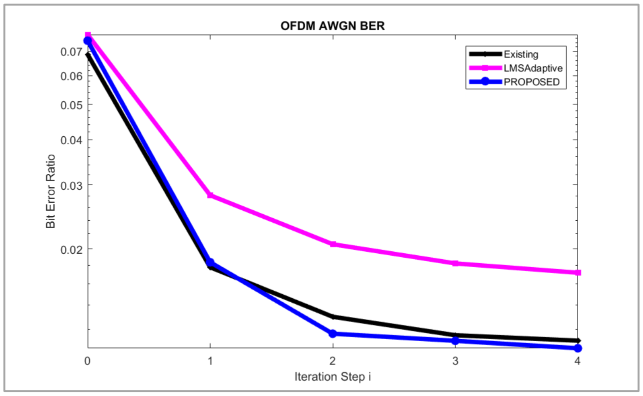

Fig.12: Bit error rate comparison in different iteration

In Fig.12 show the OFDMA channel on Rayleigh noise. In this figure comparison between wiener filter, FPA optimize Adaptive Filter and Proposed which optimize the prior of adaptive that's why reduce the BER more than Werner Filter. But Rayleigh channel not significant increase performance of Existing because of Rayleigh channel highly variable noise.

Table4.1 SNR and Datarate comparsion.

Method	Datarate	SNR	DATASNR	PilotSNR
LMS ADAPTIVE	2.53Mbits/sec	0	-0.2	2.8
Existing	2.56Mbits/sec	0	0	3.7
PROPOSED	2.72Mbits/sec	0	-0.3	2.5

V. CONCLUSION

An efficient design of channel estimation technique for OFDMA system is presented and this design has been optimised using Particle Swarm optimisation technique. The design is simulated using MATLAB. This particle swarm 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]. GauravMathur, T.Ramya, Jagadish.M, "Performance Analysis of Single-Carrier FDMAin 2x 1 MIMO Systems", IEEE International Conference on Communication and Signal Processing, pp.1050-1053, 2014.

[2]. Sanjana T and Suma M N, "Comparison of channel estimation and equalization techniques for ofdm systems*"*,Circuits and Systems: An International Journal (CSIJ), Vol. 1, No. 1, pp 1-10, January 2014

[3]. Hyun-Myungkim, Dongsik Kim, Tae-Kyoung Kim, Gi-Hong Im, "Frequency Domain Channel Estimation for MIMO SC-FDMA systems with CDM pilots", IEE Journal of Communications and Networks, Vol 16, No. 4, pp 447-457, 2014.

[4]. Qiang Li, Yuchun Wu, ShulanFeng, Philipp Zhang, LixiaXue, Yongxing Zhou, "On Channel Estimation for Multiuser MIMO for LTE-A Uplink" IEEE, 2014

[5]. Dan Li, FengKe, "Fast time-varying channel estimation method for LTE SC-FDMA systems", IEEE International Conference on Acoustic, Speech and Signal Processing (ICASSP), pp. 6524-6528, 2014.

[6]. Yongkui Ma, Ping Tan, Xiaoyu Wang, Dianwei Li, "Research on Channel Estimation Based on Adaptive filtering for LTE uplink", IEEE conference on Consumer Electronics, communication and networks, 2012, pp.2010-2014.

[7]. Soma Umamaheshwarb, Tipparti Anil Kumar, KunupalliSrinivasaRao, "A robust channel Estimation for OFDMA system", International Journal of Research and Applications (2014 Transactions), vol. 1, Issue 3, pp 80-83, 2014.

[8]. Zhang, Hua, Ying Yuan, and Wei Xu. "PAPR reduction for DCO-OFDM visible light communications via semidefinite relaxation." *IEEE Photonics Technology Letters* 26.17 (2014): 1718-1721.

[9]. Ye, Chen, et al. "PAPR reduction of OQAM-OFDM signals using segmental PTS scheme with low complexity." *IEEE Transactions on Broadcasting* 60.1 (2014): 141-147.

[10]. Li, Li, DaimingQu, and Tao Jiang. "Partition optimization in LDPC-coded OFDM systems with PTS PAPR reduction." *IEEE Transactions on Vehicular Technology* 63.8 (2014): 4108-4113.

[11]. Ji, Jinwei, GuangliangRen, and Huining Zhang. "PAPR reduction in coded SC-FDMA systems via introducing few bit errors." *IEEE communications letters* 18.7 (2014): 1258-1261.