Novel Approach of Wavelet Transformation by water cycle optimization in multiuser MIMO OFDM

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Abstract- Due to enhancement in the wireless devices the requirement of the data places is also increased and demand of bandwidth is also enhanced. This is also necessary for the throughput and capacity of the communication system. MIMO-OFDM is the novel technique which meets with the needs of communication process. OFDM is used in multiple devices because it provides high spectral efficiency and resilience to multipath channel effects. OFDM make the process of channel equalization simple and it is sensitive to synchronization errors. The MIMO-OFDM approach is used to enhance the throughput of the channel without increasing the bandwidth or power. The main issue in the wireless communication is multipath fading. This issue occurred due to the arrival of transmitting signal from different paths. These signals arrived on the receiver through different angles with different time delay and frequencies. The fluctuation in the signal power results into multipath fading and limited bandwidth which makes designer's task challenging and data rate and reliability is also low. The proposed work describes the detail on MIMO-OFDM and work on the issues like this. The proposed work based on the GWO algorithm for effective and optimized results. The result of the experiment shows the significance improvement of BER and reduction in SNR with different modulation and noisy channel.

Keywords—*MIMO-OFDM, GWO, optimization*

I. INTRODUCTION

The major challenge facing future wireless communication systems is to provide high data rate wireless access with high quality of service (QoS). The combined spectrum is a scarce resource and the fact that the propagation conditions are hostile due to fading (caused by the destructive addition of multipath components) and other users' interferences, this requirement require fundamentally improved spectral efficiency and improved link reliability. Multiple Input Multiple Output (MIMO) remote advancements appear to meet these prerequisites by giving higher unearthly productivity through spatial multiplexing pick up and enhancing join dependability because of receiving the wire decent variety pick up. In spite of the fact that there are as yet numerous open research issues in the field of MIMO remote from the point of view of MIMO hypothesis and equipment execution, this innovation has achieved the phase that can be utilized as a part of real frameworks. Indeed, the primary item in view of MIMO innovation are now available. Multi-transmitting and numerous accepting radio wires, i.e, various information different yield (MIMO) innovation, can fundamentally be isolated into two gatherings: space time coding (STC) and space division multiplexing (SDM).

1.1 OFDM

Orthogonal Frequency Division Multiplexing (OFDM) is an effective technique for alleviating ISI. OFDM is a Frequency Division Multiplexing (FDM) scheme used as a digital multi-carrier modulation method. In other words, OFDM is a frequency division multiplex of multiple carriers, which are orthogonal to each other, i.e they are exactly placed in the zeros in the modulation spectrum of each other. This makes OFDM all the more frightfully effective. In OFDM, information is isolated into a few parallel information streams or sub-channels, each sub-bearer being orthogonal to each other in spite of the fact that they are frightfully covering. Each sub-bearer utilizes a regular tweak conspire, (for example, QAM or PSK) at a low image rate, keeping up a similar general information rate as a customary single-transporter adjustment plot inside a similar data transfer capacity. In the present circumstance, MIMO is extremely helpful for the blend of OFDM frameworks. The utilization of the adaptability of the MIMO framework to get high information rates is an especially alluring exploration theme for the plan and use of future booking plans.

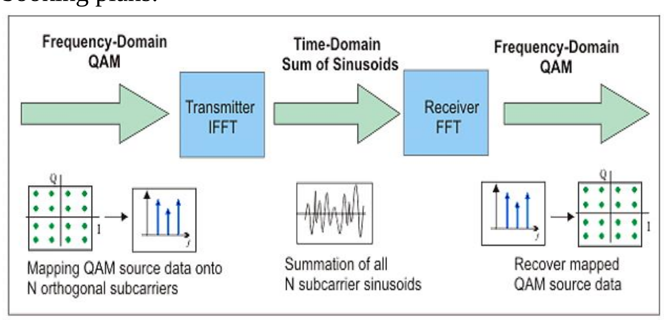

Fig.1 OFDM Block Diagram

Compared to conventional single-input single-output (SISO) systems, multiple-input multiple-output (MIMO) systems provide greater channel capacity.

Orthogonal Frequency Division Multiplexing (OFDM) is one of the most promising physical layer technologies in high data rate wireless communication due to its robustness to frequency selective fading, high spectral efficiency, and low computational complexity. OFDM can be utilized as a part of conjunction with a different info numerous yield (MIMO) handset to expand decent variety pick up or potentially framework limit by misusing the spatial space. Since OFDM frameworks successfully give numerous parallel restricted band channels, MIMO-OFDM is viewed as a key innovation in developing high information rate frameworks such as 4G, IEEE 802.16 and IEEE 802.11n.

1.2 MIMO- OFDM

Multiple Input Multiple Output Orthogonal Frequency Division Multiplexing (MIMO-OFDM) is the primary air interface for 4G and 5G broadband wireless communications. It consolidates various info numerous yield (MIMO) innovation to expand the limit by transmitting distinctive flags over different reception apparatuses, and Orthogonal Frequency Division Multiplexing (OFDM) innovation, which separates the radio channel into countless dispersed sub-channels. To give higher speed and dependable interchanges. Research conducted in the mid-1990s showed that while MIMO can be used with other popular air interfaces such as Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA), the combination of MIMO and OFDM is higher Data rate. MIMO-OFDM is the premise of the most progressive remote LAN (Wireless Local Area Network) and portable broadband system models since it accomplishes the most elevated ghostly effectiveness and subsequently gives the most astounding limit and information throughput. Greg Raleigh concocted MIMO in 1996. He demonstrated that by utilizing spatially transmitted signals to reflect objects, (for example, the ground) and utilizing numerous ways to achieve a similar recurrence, diverse information stream collectors can be transmitted at the same time on a similar recurrence. Information, distinctive information streams can be sent through various ways.

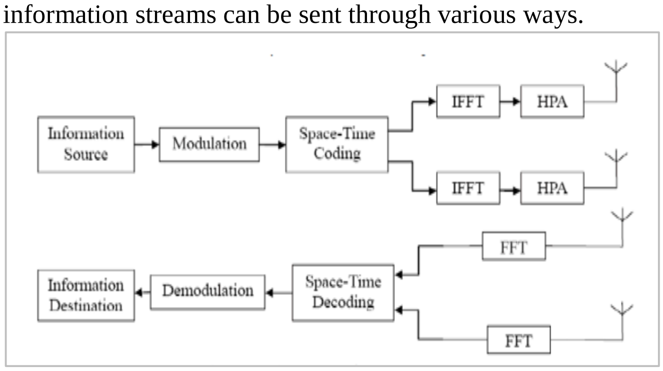

Fig.2 Structure of MIMO-OFDM

Raleigh proposed and later demonstrated that with OFDM, the preparing required for MIMO at higher rates will be the most straightforward to oversee. Modulation, because OFDM converts high-speed data channels into multiple parallel low-speed channels [1]. Fig. Figure 1 shows the basic structure of a MIMO OFDM system.

1.3 OFDM Advantages

OFDM has been utilized as a part of the numerous high data rate remote frameworks in view of the many points of interest it gives.

Immunity to selective fading: One of the fundamental focal points of OFDM is that it is more impervious to recurrence particular blurring than a solitary bearer engineering since it partitions the regular channel into narrow band signals that are just influenced by the level blurring sub-channels.

Resilience to interference: The interference that appears on the channel may be limited by bandwidth and in this way does not affect all sub-channels. This means that not all data will be lost.

Spectrum efficiency: With closely spaced, overlapping subcarriers, the significant advantage of OFDM lies in the efficient use of the available spectrum.

Resilient to ISI: Another advantage of OFDM is that it is very flexible for inter-symbol and inter-frame interference. This is due to the low data rate on each sub-channel.

Resilient to narrow-band effects: With sufficient channel coding and interleaving, images lost due to channel's repetitive selectivity and limited band impedance can be recovered. Not every single data will be lost.

Simpler channel equalization: One problem with CDMA architecture is the complexity of the channel balance that must be connected across the entire channel. The advantage of OFDM lies in the use of various sub-channels, the channel balancing becomes quite complex.

1.4 Application of OFDM

- Used in digital audio broadcasting.
- Used in Video broadcasting.
- IEEE 802.16
- IEEE 802.20 [6]
- It is used in WiMax.

1.5 OFDM variants

In the technical literature, there are several other variant acronyms. These follow the basic format of OFDM but have other attributes or variants:

COFDM: Coded Orthogonal Frequency Division Multiplexing. A form of OFDM where error correction coding is incorporated into the signal.

Flash OFDM: This is an OFDM variant developed by Flarion, which is a fast frequency hopping OFDM. It uses multiple tones and fast jumps to propagate signals in a given frequency band.

OFDMA: Orthogonal Frequency Division Multiple Access. When using OFDM technology, a scheme for providing multiple access capabilities for applications such as cellular telecommunications.

VOFDM: Vector OFDM. This form of OFDM uses the concept of MIMO technology. It was developed by CISCO Systems. MIMO stands for Multiple Input Multiple Output, and it uses multiple antennas to transmit and receive signals so that multipath effects can be utilized to enhance signal reception and increase supportable transmission speeds.

WOFDM: Wideband OFDM. The concept of this form of OFDM is that it uses a sufficiently large degree of spacing between channels so that any frequency error between the transmitter and receiver does not affect performance. It is especially suitable for Wi-Fi systems.

II. RELATED WORK

Deshmukh, et al [1] analyzed the different digital modulation schemes like QPSK and BPSK. In this QAM is performed with the help of space time block codes. This method controls the errors by using time and spatial dimensions. OFDM system combines with antenna array at transmitter and receiver which enhance the diversity gain known as MIMO-OFDM. It improves the system capacity on time-variant and frequency selective channels. This method improves the BER rate. Ashdown, Jonathan D., et al. [2] investigated the method of high rate data transmission through metallic barriers using ultrasound. MIMO-OFDM is used to avoid the cross talk mitigation. In this a channel array is formed with the help of steel barriers. In these investigation effects of cross talk is discussed. It shows the effects of transducer misalignment on multi-channel capacity and data transmission rates. Vamsidhar [3] worked on the multi-user MIMO-OFDM for BPSK modulation approach by using Discrete Wavelet method. The proposed concept is firstly fit in the area of Wi-Fi verbal schemes. The double multi-carrier scheme is performed on the simulator with Haar Wavelet. The performance of the proposed system is efficient than the existing system and reduce the bit error rate and using both antennas BPSK and QPSK for modulation on AEGN channel. Logesh, R. et al [4] worked upon review the techniques and approaches of hybrid power generation system. In this author discussed about the structure of converters and their operations. The author also focused on the challenges related to PV integrated power generation techniques. . The execution of the proposed controller was checked from reenactments and associations. Beguilement happens displayed that the execution of the proposed ANFIS based Neuro-Fuzzy Controller could moist out the rehash deviation and achieve the steady express a driving force with less settling time Kumar, Arun et al. [5] designed MIMO-OFDM by using 4: 8 antenna and OSTBS encoder which combines the different techniques and used to control the inter-symbol interference. Performance evaluation of the proposed system is done by using Bite error rate, signal to noise ratio, constellation plot and MSE. Zheng, Beixiong, et al. [6] investigates the MIMO-OFDM with index modulation method which provides the flexible trade-off between spectral efficiency and error performance in 5G wireless communication. In this work author detects the inter channel interference which is a challenging task. It is done by using low complexity detectors which is based on Monte Carlo theory. These detectors work on the sub-blocks level and sub-carriers level to reduce the complexity. Basar, Ertugrul. et.al. [7]. Investigates the MIMO-OFDM with index modulation method which provides the flexible trade-off between spectral efficiency and error performance in 5G wireless communication. In this work minimum means square error detector and maximum likelihood detector are proposed for performance investigation. Khushboo Pachori et.al [8] introduced the active partial sequence for PAPR reduction in MIMP-OFDM. The proposed work is done in the Rayleigh fading environment. The proposed APS approach is combined with approximate gradient and partial transmit sequence. The proposed approach gives effective outcome by reducing the PAPR and does not affect the BER performance. Tazvinga et al [9] formulated optimal energy management model of solar hybrid battery. This model reduces the cost of fuels and battery and finds the optimal flow of power. The performance of the proposed approach is analyzed on 24 hours period of power supply. . In this way, the voltage-balancing out controllers were coordinated into the system with a specific end goal to keep the voltage size and recurrence consistent at the heap terminals, which requires steady voltage and recurrence. Xudong Zhu et.al [10] worked on the channel estimation process which is aware of sparsity and based on the SNR detection. This method is used to detect the sparsity level of the channel. If the priori is matched with the CS model subspace pursuit algorithm is used otherwise improved method for channel estimation is used. The result of the proposed approach represent its robustness and performs better than the existing approach. Subudhi, et al [11] proposed an average solar powered board which can change over only 30 to 40 percent of the scene sunlight based light into electrical imperativeness. Greatest power point following method is used to upgrade the productivity of the sun based board. In this way, the MPP of a photovoltaic exhibit is a basic piece of a PV framework. Thusly, numerous greatest power point following (MPPT) approaches have been made and executed. Among these methodologies, slant climbing MPPT, for instance, pester and watch (P&O) was used by numerous analysts. The issue considered by MPPT methods is to consequently locate the ideal voltage (V M P) or current (IMP) at which a PV module ought to work, under a given sunlight based irradiance and temperature. Irritate and watch strategy is the most generally utilized procedure on account of its straightforwardness and simplicity of implementation. It requires two sources of info; estimation of the present (Ipv) and estimation of the voltage (V pv). Ahmad Helmi Azhar et.al [12] the proposed work is done on the indoor wireless transmission using visible light. The proposed work is done on the 4 channel MIMO network which used the LED sources to transmit the data by using orthogonal modulation approach. The signals are detected by using the imaging diversity receiver. The average bit error rate is achieved at the room level illumination.

Prittu Ann Thomas et al. [13] had presented a survey on different modulation schemes which have higher performance for use in uplink communication. The authors had analysed OFDM scheme as a choice for high data rate wireless communication system. OFDM system provides tolerance towards multi-path delay spread and it is also robust to channel dispersions. One of the major limitations of OFDM considered is the large variation in signal amplitude which gives it a high value of PAPR. So the OFDM signals with high PAPR suffer from problem of nonlinear distortion due to non-ideal behaviour of High Power amplifiers. Also it is detrimental for battery powered devices like mobile phones which are power limited. But SC-FDMA system gave better PAPR reduction than OFDMA system and had become a modulation choice for uplink communication in Long Term Evolution (LTE).

III. THE PROPOSED METHOD

3. Proposed Algorithm

Grey Wolf Optimizer (GWO): The latest bio-inspired algorithm is the grey wolf optimization algorithm. This algorithm's main concept is simulating the behavior of grey wolf living in a pack. They have a serious hierarchy of social dominance. Alpha is known as the level leaders and is responsible for decision making in the pack. The wolf pack persistence is based on the decision of alpha. Beta is known as the second level subordinate wolves. The beta operation is for help in making the decision for alpha or other activities.Delta is known as the third level subordinate wolves. This category member consists of elders, scouts, hunters, caretakers, and sentinels. For region boundary observation and in any danger case, scouts are liable for the warning. The protection and pack's safety guarantee is given by sentinels. The expertise wolves are the elders, denoted as alpha or beta. Alphas and betas are helped by hunters while prey hunting and caring for the ill, weak, and wounded wolves by caretakers and providing food for a pack. Omega is the lowest level. All dominant wolves with omega wolves have to comply. 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 guide the hunting while position should be updated by the omega wolves by these three best solutions consideration.

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

Z_α, Z_β, and Z_ω are determined,

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

The parameter x updating is the final process. The parameter x exploitation and exploration is updated linearly for ranging [2,0] in every iteration.

$$x = 2 - t\frac{2}{maxI}$$

Where

T←iterative number

MaxI←total number of iteration

B. Proposed Steps

Step1: Encode by using QAM and BPSK Encoder.

Step 2: Map signals by using signal Mapper.

Step 3: Send the mapped signal to space time block coder.

Step 4: Input the values into grey wolf optimization algorithm for optimization process.

Step 5: If optimized the go to step 7 otherwise repeat step 4.

C. Proposed methodology: Algorithm/Flowchart

Algorithm: GWO

Step 1: Input binary data stream.
Step 2: Encode by using QAM and BPSK Encoder.
Step 3: Map signals by using signal Mapper.
Step 4: Send the mapped signal to space time block coder.
Initialize GWO $\boldsymbol{A_i}$(i=1, 2, …n)
Initialize x, X, and Y
Step 5 : Calculate fitness function for every search agent
$\boldsymbol{A_\alpha}$←best search agent
$\boldsymbol{A_\beta}$← second beat search agent
$\boldsymbol{A_\delta}$← Third best search agent

While (T<Max iterations)
  For ($\boldsymbol{X_i}$ in every pack)
    Update current position of wolf by eq. (1)
    Update x, X and Y
    Calculate the fitness function for all search agents
    Update $\boldsymbol{A_\alpha}$, $\boldsymbol{A_\beta}$, and $\boldsymbol{A_\omega}$
  End for
    For best pack insert migration ($\boldsymbol{m_i}$)
    Evaluate fitness function for new individuals selection of best pack
    New random individuals for migration
End if
End while

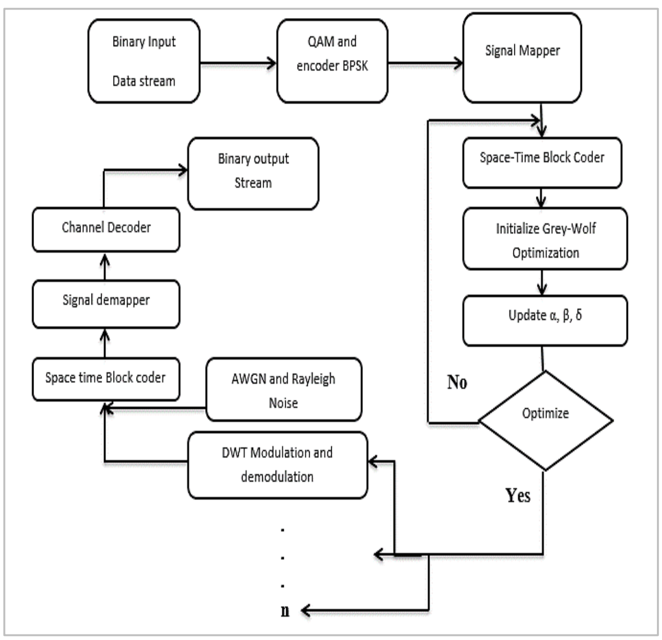

Fig.3 Proposed Flowchart

IV. RESULT ANALYSIS

The proposed approach is presented in the graphical form on the different parameters by using three modulation approaches that are QPSK, BPSK QAM. The experiment is performed on AWGN (Additive White Gaussian Noise) and Rayleigh. The parameters used for the performance evaluation are:

BER: Bit Error Rate; SNR: Signal to Noise Ratio

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.1 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 FDMA
Relative Velocity	120Km/hr
IFFT size	1024 bits

Table.2 Rayleigh on QPSK, BPSK and QAM

SNR	QPSK	BPSK	QAM
4	0.06	0.07	0.072
8	0.08	0.010	0.011
12	0.010	0.014	0.016
16	0.016	0.018	0.019

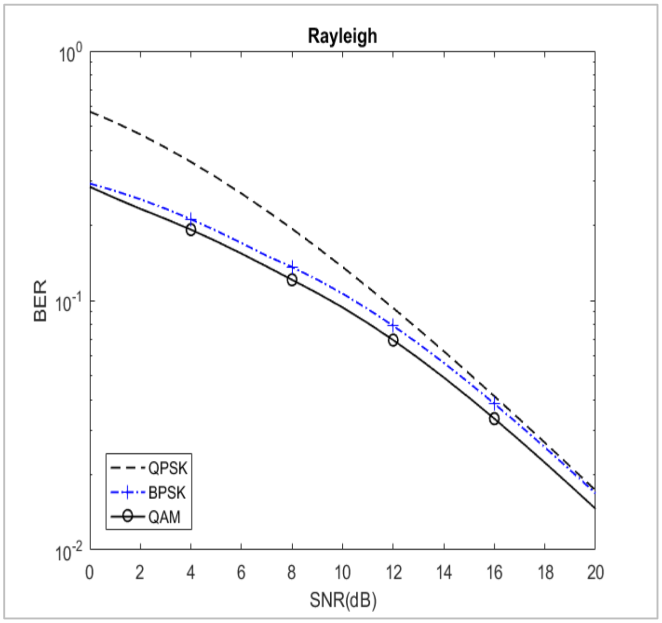

Fig.4 Rayleigh on QPSK, BPSK and QAM

In Fig.4 show the Rayleigh graph on QPSK, BPSK and QAM. In this graph X-axis represents the value of SNR (Signal to Noise Ratio) and Y-axis represents the value of BER (Bit Error Rate). The Black dotted line show the highest value of Rayleigh of QPSK on graph, Blue dotted line show the values less than QPSK and the solid Black line represents the value of QAM whose value is less than the other two methods (QPSK and BPSK).

Table.3 AWGN on QPSK, BPSK and QAM with GWO (Grey Wolf Optimizer)

SNR	BPSK_GWO	QPSK_GWO	QAM_GWO
2	0.011	0.013	0.015
4	0.014	0.016	0.017
6	0.016	0.023	0.024
8	0.018	0.042	0.052
10	0.020	0.069	0.070
12	0.022	0.076	0.078
14	0.026	0.000	0.000
16	0.032	0.000	0.000
18	0.043	0.000	0.000

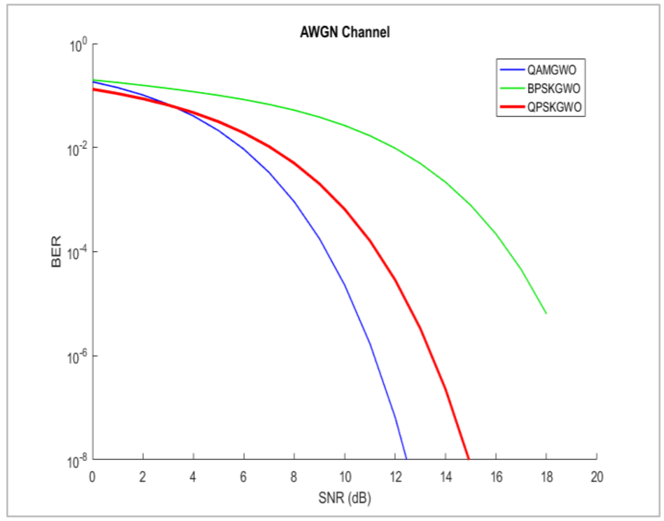

Fig.5 AWGN on QPSK, BPSK and QAM with GWO (Grey Wolf Optimizer)

In Fig.5 QPSK, BPSK and QAM are performed with GWO (Grey Wolf Optimizer). In this graph X-axis represents the value of SNR (Signal to Noise Ratio) and Y-axis represents the value of BER (Bit Error Rate). In this figure Blue line shows the value of QAM with GWO, Red Line shows QPSK with GWO and Green line shows the value of BPSK with GWO. The figure shows the value of QAM with GWO is low and the green line BPSK with GWO has highest value on AWGN channel. The red line QPSK with GWO is low in starting but as the SNR is increased its values is also enhanced.

Table.4 AWGN on QPSK, BPSK and QAM with GWO (Grey Wolf Optimizer)

SNR	BPSK	QPSK	QAM
4	0.000	0.003	0.004
8	0.000	0.008	0.011
12	0.006	0.010	0.016
16	0.008	0.018	0.019

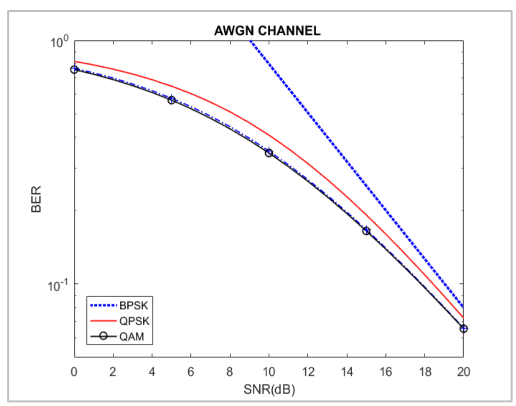

Fig.6 AWGN on QPSK, BPSK and QAM with GWO (Grey Wolf Optimizer)

In Fig.6 QPSK, BPSK and QAM are performed with GWO (Grey Wolf Optimizer). In this graph X-axis represents the value of SNR (Signal to Noise Ratio) and Y-axis represents the value of BER (Bit Error Rate). The blue line in figure presents BPSK, red line presents the QPSK and solid black line presents the values of QAM.

Table.5 Comparisons of QPSK and QAM with GWO and Without GWO

SNR	QPSK	QPSK_GWO	QAM	QAM_GWO
5	0.08	0.002	0.008	0.018
10	0.003	0.004	0.013	0.020
15	0.005	0.006	0.024	0.030
20	0.011	0.010	0.033	0.037
25	0.024	0.028	0.039	0.041
30	0.029	0.039	0.046	0.048
35	0.032	0.046	0.051	0.052
40	0.039	0.049	0.058	0.059

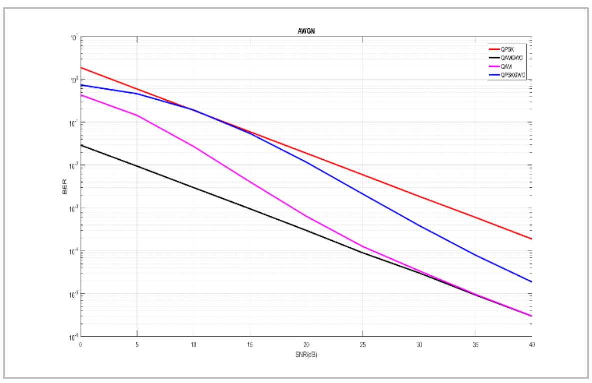

Fig.7 Comparisons of QPSK and QAM with GWO and Without GWO

In fig.7 the comparison of the QPSK and QAM with GWO and Without GWO is performed to analyze the performance on AWGN channel. In this graph X-axis represents the value of SNR (Signal to Noise Ratio) and Y-axis represents the value of BER (Bit Error Rate). The red line shows the values of QPSK, blue shows QPSK with GWO, pink line shows QAM and black line shows the values of QAM with GWO.

V. CONCLUSION

The issue of inter-symbol interference is assisted due to high data transmission rate in wireless channels and distortion is occurred in signal transmission. The issue of ISI is resolve by using the complex receiver structure. The multiplexing approach is used for it as a simple solution called as Orthogonal Frequency Division Multiplexing (OFDM). In this technique data is transmitted over multiple channels that are orthogonal to each other. In this high rate data is converted into small data streams and transmitted to subcarriers and it converts the selective channels into a set of flat fading channels. The next communication technique Multiple-input multiple-output enhance the performance level of the system. It employs multiple antennas at the sender and receiver end which transmits the data at same frequency bands. This method is also known as spatial multiplexing which enhance the spectral efficiency and reliability without using any additional transmit power. This technique come at the extent cost and increase the computational complexity as compare to the traditional antenna system. To identify the strengths and weakness of the new approaches many experiments are performed and requires testing. In this work it is concluded that the proposed approach performs better due to the optimized results of the Grey Wolf Optimization algorithm and performs effectively on BER and SNR parameters. The proposed work open a lot of research areas in this field.

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