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IMPLEMENTATION OF FLIP OFDM ALONG WITH ITERATIVE RECIVER FOR BETTER RECEPTION

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Abstract
EM spectrum is considered as scariest resources in the world as the demand is increasing and resources are keep on reducing. Along with time, traffic is increasing and OWC is considering as promising technique for using RF resources in efficient manner especially in short and medium range of communications. In the paper an efficient flip OFDM mechanism is utilized along with iterative receiver to improve the transmission and finally results show proposed method yield good performance.
Keywords: OWC, Flip OFDM, Cyclic prefix, Iterative receiver

1. INTRODUCTION

Orthogonal frequency division multiplexing (OFDM) and compatible usage in wireless standards like DVB, WIMAX, IEEE802.11a and LTE has been gained interest from worldwide research organizations. Recently an international meeting has conducted in order to discuss importance of orthogonal frequency division multiplexing (OFDM) and its usage in advance wireless standards makes Orthogonal frequency division multiplexing (OFDM) as an emerging technology to meet the requirements in practical scenario. Orthogonal frequency division multiplexing (OFDM) has high data rates compared to traditional communications systems and it suited well for frequency selective channels. Large delay spreads is a drawback which commonly occurs in the high speed wireless communication system and orthogonal frequency division multiplexing (OFDM) modulation scheme has ability to transform the wide frequency selective channel to narrow ones which creates the robust environment to resists against occurrence of the large delay spreads and preserves the Orthogonality in perfect way in the frequency domain. Orthogonal frequency division multiplexing (OFDM) has one more unique advantage to reduce the complexity in the system by introducing the cyclic prefix at the transmitter end and performing scalar equalization at the receiver end in the wireless standards like WIFI and WIMAX [1].

In 21st century, the role of the technology to offer high data rates and mobility is crucial and the technology is changing its face every other because of immense research work carried out on the advance wireless

communications. Actually the research on parallel data transmission is traced out in the mid 1960's but it takes 25 long years to make it compatible to real time applications. The OFDM gradually seen its presence in the various application and now various international standards consider it as promising modulation scheme which initially supports wireless standards like WIFI, WIMAX, LTE etc. The two important parameters required better transmission of data from one entity to another are data rate and the modulation scheme should support different channel conditions to obtain better spectral efficiency. The evolution of the third Generation Partnership Project (3GPP) development based on the Long term evolution (LTE) supports two networks namely Radio access network (RAN) and core network. The transformation of the 3G to 4G observes the changes in terms of data rate and spectral efficiency. International Telecommunication Union Radio communication Sector (ITU-R) initialized a set of requirements for the 4^{th} generation cellular system and requirement of the high data rate is specified by International Mobile Telecommunications Advanced project (IMT-Advanced) for 4G. OFDM is a modulation scheme which is one of the techniques employed in LTE to enhance the data stream. Transmission of the digital data through multipath environments has been considered as area of concern in the future wireless communication system. Advancement in the technological aspects paves way to design an advance modulation scheme namely orthogonal frequency division multiplexing (OFDM). Orthogonal frequency division multiplexing (OFDM) modulation scheme has ability to transmit the information through multipath environments [2].The bandwidth utilization is called as spectral efficiency and the bandwidth occupied by the orthogonal frequency division multiplexing (OFDM) is directly relates to transmission data rate. The commonly occurred question arise in the orthogonal frequency division multiplexing (OFDM) modulation scheme is how to obtain better diversity levels and mitigating the loss of signal in adverse fading environments.Occupied bandwidth is of course directly related to the data rate to transmit. However, the question is, what is the minimum bandwidth required to be taken in order to obtain enough diversity and avoid the loss off the entire signal in frequency selective fading environments. On the other hand much bandwidth means also much transmitting power. There is a tradeoff between bandwidth and transmitted power. Compared to conventional FDM modulation scheme OFDM achieves good optimal bandwidth which were found after conducting the various filed test trails and channel simulations. For example, a bandwidth of 1.5 MHz is achieved for the type of propagation conditions in the Digital audio broadcasting application. The optimal bandwidth is found by channel simulations and field test trials. In Digital Audio Broadcasting (DAB), for example, a bandwidth of 1.5 MHz is a good compromise for the type of propagation conditions that apply [6].

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2. BACKGROUND

2.1 COMMUNICATIONS, OFDM AND DRAWBACKS

As technology transforming it's appearance along with the generation and time respectively, then according to that Communication is also evolving it's way in secured and faster day by day to give more comforts to the mankind and now the communication has touch it's new level where once upon a time the planet earth is termed as 'Concrete jungle' by many people and now due to the high advanced technological developments in the aspects of communications now the planet earth is called as 'Transforming world'. In olden communication means a way of approach to communicate with people with near and far end people. As in olden days Travelling on animals is only source to communicate with the dear ones on the longer distances. As Kingdoms starts to expand to show superiority slowly new places came to existence which is already their but has to be discovered like USA etc. Then water travelling too starts using to communicate with people on longer distance but it takes too long time.Then the beginning of the industrialization starts which creates drastic changes in making way of living and way of thinking. It shows its impact in such a way that the development from 1000 A.D. to 1600 A.D. is considered as one era and the development from 1600 A.D. to 2000 A.D. is considered as one era. The industrial era mainly concentrates to provide more and more comfort to mankind by decreasing strength and increasing productivity. This industrialization era starts showing its impact on communications domain. This revolution in the communication domain starts with the invention of telephone by the graham bell which creates the way for the new ideas in the future generation for better communication techniques.The communication techniques have been broadly classified into two categories namely wireless and wire communications respectively. At the time of world war to show the superiority over each other the axle and axis powers starts inventing new way of communications although it starts for bad cause but at the end it has done good for mankind and the wireless communications came into existence. At the starting the wireless communications have been used for high level military communication purposes and some high equipped purposes. After some years it came to public service by the USA at first. Later on spectrum starts playing crucial role as all know the communication which we are making through the mobile and internet are possible because of the microwaves which are next to the radio waves which are termed as long distance communication waves.Communications are classified into three different sections based on the different aspects as discussed below. After comparing with traditional communication techniques namely FDMA, TDMA, CDMA orthogonal frequency division multiplexing (OFDM) communication system has great spectral efficiency and high data rate.

(i) Conventional communications techniques
    (a) FDMA
    (b) TDMA

(ii) Existing Communication systems
    (a) CDMA

(iii) Future generation communication techniques

(a) FDM

(b) OFDM

2.2 ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) SYSTEM

Orthogonal frequency division multiplexing (OFDM) communication system has number of advantages over conventional communication techniques namely FDMA, TDMA and CDMA. Orthogonal frequency division multiplexing (OFDM) communication system has better spectral efficiency, high data rate, low inter carrier interference and moreover it is termed as future generation communication system because of its flexible and reliable high speed data rates, high spectral efficiency, high quality service and robustness against narrow band interference and frequency selective Fading.Orthogonal frequency division multiplexing (OFDM) communication technique is recognized in the communications area for its high speed communications. The Orthogonal frequency division multiplexing (OFDM) communication technique has many advantages compares to the conventional communication techniques as follows

(i) High spectral efficiency

(ii) Immunity to the effects of fading

3. LITERATURE REVIEW

(1) A novel 4G cellular system based research oriented review paper is proposed by IAN F. AKYILDIZ ∗, DAVID M. GUTIERREZ-ESTEVEZ, ELIAS CHAVARRIA REYES in the year 2010. The analysis of the LTE (Advanced) and detailed review on the technologies related to the LTE (advanced) are discussed in the paper. Initially the optimized evolution from the 3G to 4G is discussed in detailed way based on the properties and characteristics. The novel thing presents in this paper is development of the advance integration approach which integrates the current and future generation radio access technologies based on the 3GPP network architecture. In the latter step the drawbacks frequently happen are highlighted and necessary approaches are presented to resolve the issues in equipped way [3].

(2) An optimized multicarrier modulation has proposed by JOHN A. C. BINGHAM in the year 1990. The proposed method in this review work divided the transmission data into several small bit streams based on the principle of transmitting data. These divided small bit streams are used to modify the several carriers according to the properties of the data carriers and the presence of these bit streams are observed in the COLLINS KINEPLEX system [4].

(3) A bit error performance evaluation approach is proposed by L. JUN, T. TJENG THIANG, F. ADACHI, H. CHENG LI in the year 2000. The OFDM modulation scheme offers high data rate but frequently suffers from the inter carrier interference and fading which results in degradation of the bit error rate. A novel closed form formula is designed in this work for the OFDM bit error rate performance assessment in two different frequency selective channels with huge diversity reception. Here three different profiles types are used for obtaining the bit error rate curves in terms of root means square delay spread approach. The different profiles are

(i) One sided exponential profile (ii) Uniform profile and finally (iii) double spike profiles [5].

DM-MDPSK system block diagram.

(4) This review paper focuses on the work which evaluates the OFDM based multi wavelets performance by K. ABBAS HASAN, M. WALEED A., N. SAAD in the year 2010. Although OFDM has attracted attention from the worldwide researchers due to its ability to provide high data rate and mobility and at the same time OFDM suffers from drawbacks like Inter carrier interference, Inter symbol interference and delay. The reasons behind the frequent occurring of the inter carrier interference in the OFDM are its limitation in ability to use Orthogonality at the receiver end in the wireless communication reception and presence of inter carrier interference results in the abnormal accuracy in the channel tracking. Generally the cyclic prefix usage is the common approach in the OFDM modulation scheme but the presence of the cyclic prefix shows its impact on the spectral efficiency. The cyclic prefix acts as the guard interval before the ach block in the OFDM system. The role of the transform technique has great impact in assessing the OFDM performance in terms of bit error rate. Dft based OFDM offers low spectral efficiency compare to the DWT based OFDM and in this work the DWT based OFDM modulation scheme is replaced by the multi wavelets which helps in reducing the interference levels in both carrier and symbols and gradually shows good results in terms of increasing the spectral efficiency [12].

(5) A multicarrier modulation is consider as promising technique for wireless communication and a new work is proposed by K. WERNER, P. GOTZ, U. JORN, Z GEORG in the 2000. The paper focus on the ISI/ICI occurrence in the typical time changing channels and also compares the various trans-multiplexer structures. Here three types are discussed namely Wilson type, Gabor type and wavelet type and al these three represents the trans-multiplexer structures. The representation of the work is as follows

4. CONVENTIONAL METHOD

The conventional orthogonal frequency division multiplexing (OFDM) has a basis set which is orthogonal in nature which is formed by using the sinusoids of the discrete Fourier transform. In traditional orthogonal frequency division multiplexing (OFDM) approach the sinusoids of the DFT is correlated with the respective input signal and this correlation is done with the each and every sinusoidal basis function. Here the sinusoids which are used to correlate with input signal are the sub carriers of orthogonal frequency division multiplexing (OFDM) itself. Some of the important points in the DFT based orthogonal frequency division multiplexing (OFDM) are as follows

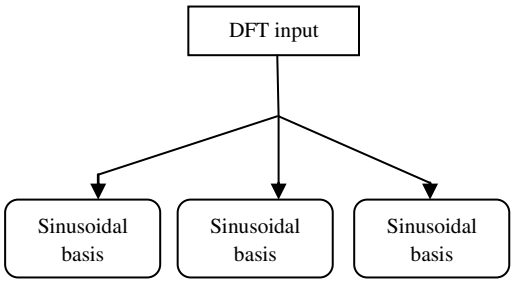

Figure 4.1: Input signal with sinusoidal basis functions correlation

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Once the transmitted information successfully transmitted at the receiver end, the receiver receives the data in combined form of signals. In order to meet the practical requirement and to accomplish the task in fast way, in OFDM fast Fourier transform (FFT) usage and inverse fast Fourier transform (IFFT) is encouraged. The main advantage of the fast Fourier transform usage is it completes the task in less number of computations when compared with traditional approaches. Due to dispersive time intervals natures at the receiver section the drawbacks like selective fading and as these multipath fading results in the ICI and ISI, and at the receiver end in order to remove this drawbacks from the OFDM system usage of (Cyclic prefix) CP is encouraged.

Cyclic prefix (CP) is generally occupies around 20% of the bandwidth means it is copy of selective part of symbol. As long as the delay spread of channel remains in the limit of the cyclic prefix there would not any loss of orthogonality in the OFDM signal. For long term evolution (LTE) application the data related to different users in the downlink scenario is multiplexed in the frequency domain and this all process is termed as the orthogonal frequency division multiplexing (OFDM). Generally the drawbacks like PAPR occurs in the orthogonal frequency division multiplexing (OFDM) due to random nature of the constructive approach of addition of subcarriers. In order to overcome the problems above mentioned a power linearization technique and a point amplifier needs to compress the abnormal power fluctuations and all this process is done at the base station(BS). But in practical all this equipment increases the cost so the usage of SC FDMA approach is encouraged in order to reduce the PAPR and all this happen. Although single carrier has far more advantages over its traditional approaches but it too suffers from drawback. In single carrier introduction of ICI is happens at the uplink scenario and in order to remove it an low complexity equalizer is required but the SC FDMA not sensitive to the parameters like Doppler shift and frequency offset.

5. PROPOSED METHOD

Iterative receiver for FLIP OFDM in optical wireless communication

We used TDMA, FDMA & CDMA in which single carrier is present, but we are going for OFDM in which we can use multiple carriers.

- OFDM(orthogonal frequency division multiplexing):

OFDM is a signal modulation that divides a high data rate stream by placing them onto many no. of closely spaced, narrowband subcarriers.

Actually OFDM is used in 4G technology because of following advantages of OFDM:

a. High spectral efficiency
b. Overlapping of signal is allowed
c. ISI & ICI are removed in OFDM

There are some disadvantages in OFDM as

a. High PAPR (peak to average power ratio)
b. Sensitive to Doppler shift.

For placing the signals orthogonally by carrier they must follow the Orthogonality property.

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- Orthogonality property:

  $\int_0^T \cos(2\pi nft) \cdot \cos(2\pi mft) = 0 \quad (m \neq n)$

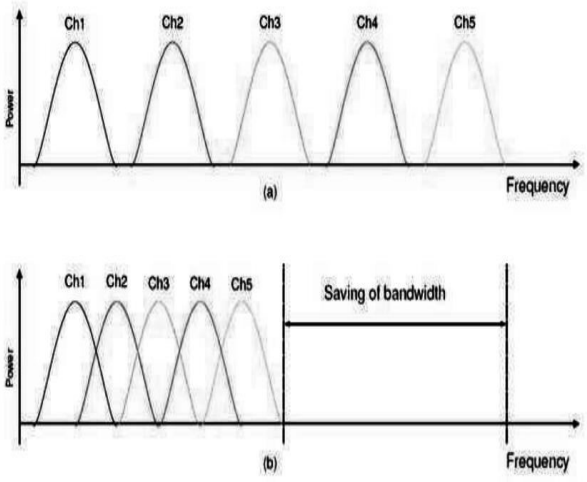

Fig .(a) FDM fig.(b) OFDM

As OFDM allows overlapping of signals, so BW used is very less i.e. some BW is saved & hence we can get high data rate.

- Flip OFDM:

  There are two main applications of Flip-OFDM :

  1. Unipolar communication system
  2. Optical wireless communication system(OWC)

Flip-OFDM is used to compensate dispersion effect in OWC.

In OWC, intensity modulation with direct detection (IM/DD) technique commonly used for data transmission.

Flip OFDM transmit the positive & negative parts of the given signal over two consecutive OFDM subframes (positive and negative subframes respectively).

- Optical wireless communication(OWC):

OWC is the optical communication in which unguided visible, infrared (IR) or ultraviolet (UV) light is used to carry the signal.

OWC is also known as visible light communication (VLC).

- Conventional receiver recovers data by subtracting negative subframe from positive subframe .
- Iterative receiver is proposed to improve the transmission performance of Flip-OFDM by using signal in both subframes.

  In this proposed method of iterative receiver provides significant SNR than conventional receiver.

Due to distinct advantages of LED's in optical wireless communication(OWC), they are more attractive & are alternative to the radio frequency (RF) system, specially for indoor use.

Convergence of illumination and communication makes OWC as one of the most important technology.

In order to achieve high data rate and to reduce the ISI , OFDM is used in OWC.

We are using intensity modulation and direct detection (IM/DD) in OWC system. then the transmitted signal must be real and non-negative which is obtained by Hermitian symmetry on OFDM subcarriers.

Further for bipolarity in OFDM, several OFDM scheme have been proposed like DCO-OFDM,ACO-OFDM & PAM-DMT.

Another one Novel OFDM technique named as Flip-OFDM is proposed.

Flip-OFDM is modified for spectral efficiency of DCO-OFDM without biasing.

conventional receiver of Flip-OFDM is simple and straightforward but it increase

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the noise variance of the received symbols, making performance very worst than Flip-OFDM of same modulation.

To improve the performance of Flip-OFDM, a time domain noise filtering technique is proposed.

In this paper, iterative receiver is proposed for Flip-OFDM for total use of structure of received signal.

Simulation of this paper confirms that the proposed iterative receiver is superior to other receiver.

- Based on transmission range optical wireless communication (OWC) has following application :

1.Ultra short range OWC:

in this type of OWC, the range is very short as chip to chip distance in multichip package

2. short range OWC:

in this type of OWC, distance is somewhat more. Under this IEEE802.15 devices come. E.g. wireless body area network(WBAN), wireless personal area network (WPAN).

Underwater communication is considered under this application.

3.Medium range OWC:

IR (infra red) radiation used for indoor applications and visible light communication (VLC) for wireless LAN (WLAN) comes under this class.

4. Long range OWC:

under this distance again increase. It include interbuilding distance.

It is also called free space optical communication(FSO).

5.Ultra long range OWC:

in this distance is very high. Satellite to satellite distance it can cover. Inter-satellite communication comes under this class.The conventional receiver is simple and straightforward, but it does not fully exploit the structures of the received signals. In the following, a new receiver is proposed by establishing the relationship between the received signals $y^+$and y^- the input data X.

Where $|x|$ can be expressed as

$|x| = S(X)x = S(X)W_N^H X$, (1)

Where S(X) is defined as

$S(X) = diag\{sign(x)\}\, diag\{sign(W_N^H X)\}$, (2)

Then the positive and negative parts can be writes as follows,

$x^+ = \frac{x+|x|}{2} = \frac{x+S(X)W_N^H X}{2}$.

The relationship between the y^+ and X can be derived as

$y^+ = \frac{HW_N^H S(X)W_N^H X - H}{2} X + Z^-$ (3)

Particularly, in line-of-sight (LOS) channels, the channel response can be expressed as

$h(n) = c\delta(n)$ (4)

and finally the iterative receiver becomes

$$\hat{X}_{LOS}^{(i)} = \begin{cases} dec[y^+ - y^-], i = 0 \\ dec\left\{\frac{1}{2}\left[I + W_N S\left(\hat{x}_{LOS}^{(i=0)}\right)W_N^H\right]y^+ \right. \\ \left. + \left[I + W_N S\left(\hat{x}_{LOS}^{(i=0)}\right)W_N^H - I\right]y^-\right\} \end{cases}$$

CHAPTER 6
SIMULATION RESULTS

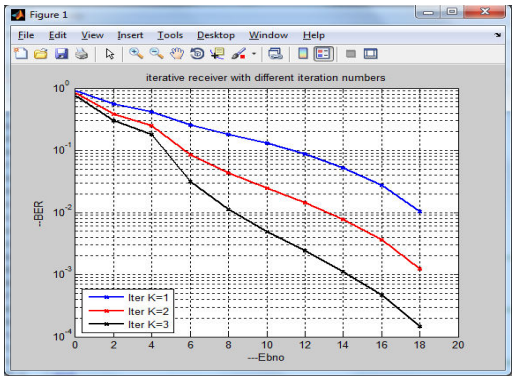

Figure 1: Iterative receiver with number of iterations

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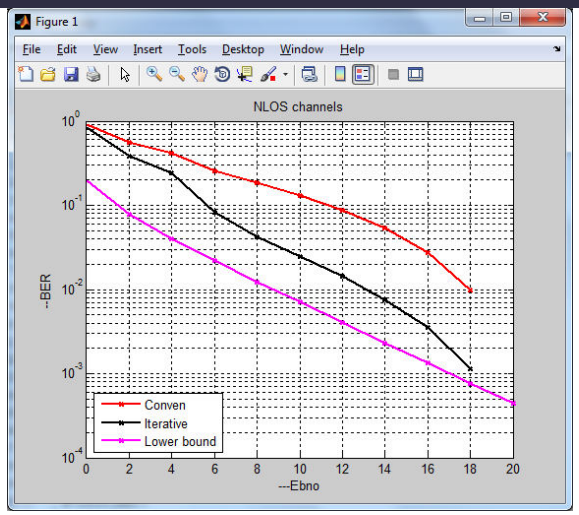

Figure 2: NLOS channel in terms of BER

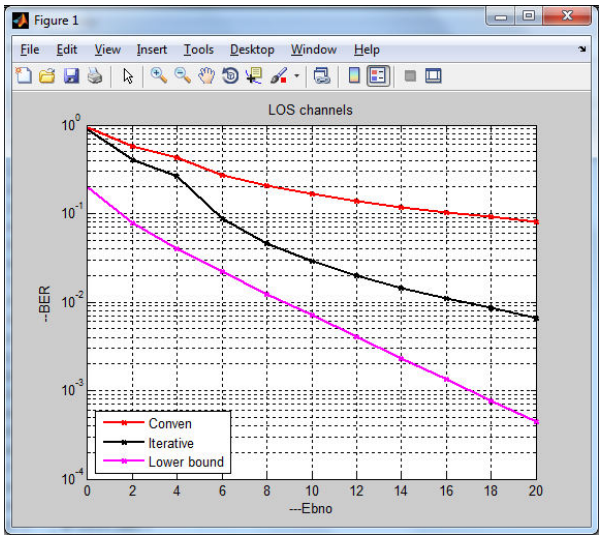

Figure 3: LOS channel in terms of BER

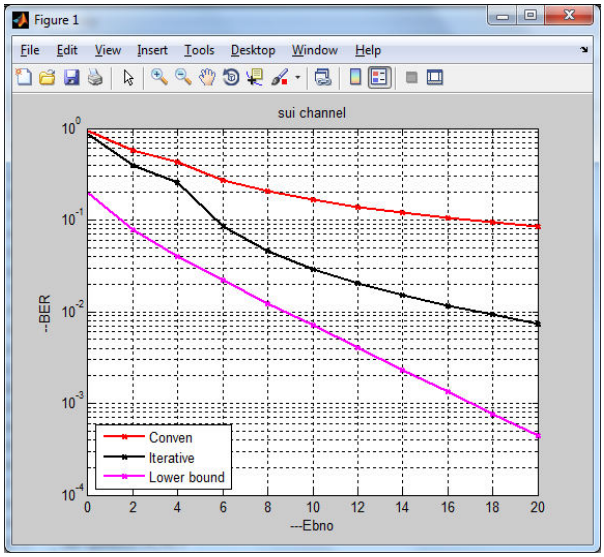

Figure 3: SUI channel in terms of BER

SNR	BER(LOS)	SUI Channel(LOS)
0	0.8945	0.8615
2	0.2225	0.2188
4	0.0988	0.0946
6	0.0550	0.0544
8	0.0352	0.0346
10	0.0231	0.0242
12	0.0174	0.0178
14	0.0129	0.0136

Compare the BER results with last 2 figures

CONCLUSION

Optical wireless communication along with the FLIP OFDM is used in this paper to improve the receiver performance in better way. Th additional gain is obtained by the iterative receiver by both frames. Finally results show significant improvement in terms of performance as well as efficiency. Iterative receiver is more equipped than the conventional receivers in all ends.

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