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A REVIEW ON ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

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Abstract—Due to the high data rate transmission and the ability to against frequency selective fading, orthogonal frequency division multiplexing (OFDM) is a promising technique in the current broadband wireless communication system. Orthogonal frequency division multiplexing (OFDM) is the recent trend in wireless technology. So, in this paper various techniques has been presented to enhance OFDM network.

Keywords— Channel estimation, Orthogonal Frequency-Division Multiplexing (OFDM), Wireless Communication, Modulation, Genetic Algorithm, Bacterial Foraging Optimization Algorithm.

INTRODUCTION

Now-a-days, OFDM is of great interest to researchers all over the world [1]. In OFDM, the entire channel is splitted into many narrow parallel sub channels, so the duration of symbol is increased and the inter symbol interference (ISI) produced by the multi-path environments is reduced or eliminated [2, 3].OFDM supports high data rate traffic because the incoming serial data stream is divided into parallel low-rate streams that are transmitted on orthogonal sub-carriers simultaneously [4]. OFDM system has the ability of extenuating a frequency-selective fading channel to a set of parallel flat fading channels, which require simple processes for channel equalization [5]. The available spectrum in an OFDM system is divided into manifold sub-carriers and all these subcarriers are orthogonal to each other [6]. OFDM has been standardized for several applications, such as digital audio broadcasting (DAB), digital television broadcasting, wireless local area networks (WLANs), and asymmetric digital subscriber lines (ADSLs) [7, 8].
Channel estimation is one of the most salient processes in communication system [9]. A perfect channel estimation algorithm should comprise both the time and frequency domain characteristics of the OFDM systems [10]. The performance of OFDM system can be improved by allowing for coherent demodulation using an exact channel estimation algorithm [11]. In OFDM transmission system, numerous channel estimation methods have been developed under the assumption of a slow-fading channel, wherein the channel transfer function remains stable within one OFDM data block [12]. Several channel estimation techniques have already been developed for MIMO–OFDM systems. These techniques are broadly classified into three categories: (1) training-based technique, (2) blind technique, and (3) semi-blind technique, which is a combination of the first two techniques [13,14].

What is OFDM?

Orthogonal frequency division multiplexing (OFDM) is a widely used modulation and multiplexing technology, which has become the basis of many telecommunications standards including wireless local area networks (LANs), digital terrestrial television (DTT) and digital radio broadcasting in much of the world. In the past, as well as in the present, the OFDM is referred in the literature as Multi-carrier, Multi-tone and Fourier Transform. The OFDM concept is based on spreading the data to be transmitted over a large number of carriers, each being modulated at a low rate. The carriers are made orthogonal to each other by appropriately choosing the frequency spacing between them. A multicarrier system, such as FDM (aka: Frequency Division Multiplexing), divides the total available bandwidth in the spectrum into sub-bands for multiple carriers to transmit in parallel [15]. It combines a large number of low data rate carriers to construct a composite high data rate communication system. Orthogonality gives the carriers a valid reason to be closely spaced with overlapping without ICI.

Principle of OFDM

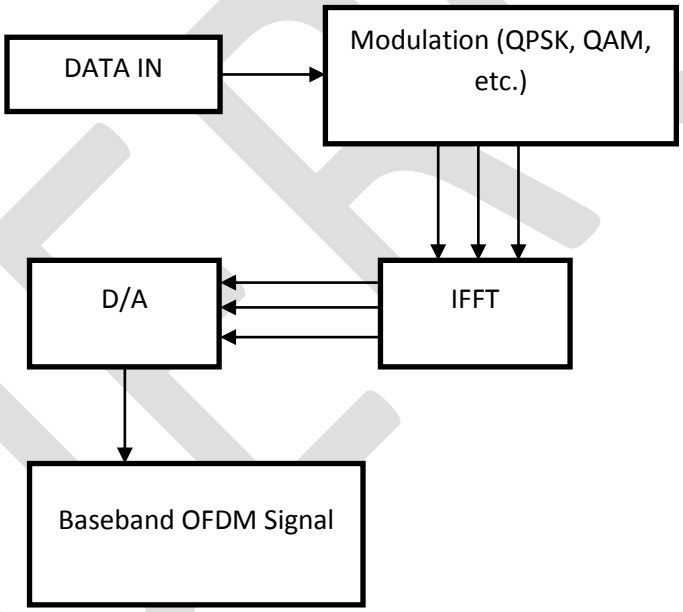
In digital communications, information is expressed in the form of bits. The term symbol refers to a collection, in various sizes, of bits [16]. The main features of a practical OFDM system are as follows:

- Some processing is done on the source data, such as coding for correcting errors, interleaving and mapping of bits onto symbols. An example of mapping used is QAM.

- The symbols are modulated onto orthogonal sub-carriers. This is done by using IFFT.
- Orthogonality is maintained during channel transmission. This can be achieved by adding a cyclic prefix to the OFDM frame to be sent. The cyclic prefix consists of the L last samples of the frame, which are copied and placed in the beginning of the frame. It must be longer than the channel impulse response.
- Synchronization: cyclic prefix can be used to detect the start of each frame. This is done by using the fact that the L first and last samples are the same and therefore correlated.
- Demodulation of the received signal by using FFT.
- Channel equalization: the channel can be estimated either by using a training sequence or sending known so-called pilot symbols at predefined sub-carriers.
- Decoding and de-interleaving.

Basic OFDM system

The OFDM signal generated by the system in Figure 1 & 2 is at baseband; in order to generate a radio frequency (RF) signal at the desired transmit frequency filtering and mixing is required. OFDM allows for a high spectral efficiency as the carrier power and modulation scheme can be individually controlled for each carrier. However in broadcast systems these are fixed due to the one-way communication. The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of



subcarrier

Figure 1 Transmitter

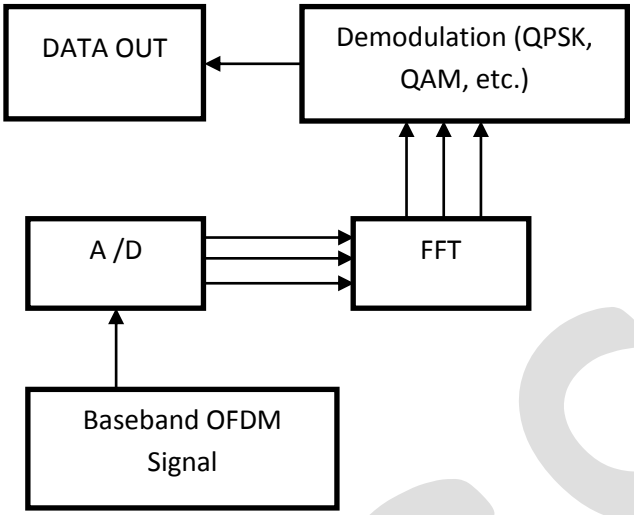


Figure 2 Receiver

The block diagram showing a simplified configuration for an OFDM transmitter and receiver is given in Fig.1 & Fig. 2.

Advantages

OFDM have several attractive features which are responsible for making it more advantageous for high speed data transmission over other data transmission techniques. They are:

- Ability to cope with severe channel conditions
- Robust against ICI and fading due to multipath propagation
- Robust against narrow-band co-channel interference
- Flexibility
- High spectral efficiency as compared to other double sideband modulation schemes
- Ease of equalization
- Efficient implementation using Fast Fourier Transform (FFT).

Disadvantages

Inspite of various advantages there are various disadvantaged of OFDM systems.

- High sensitivity to Doppler shift
- Sensitive to frequency synchronization problems
- High peak-to-average-power ratio (PAPR)
- Intercarrier Interference (ICI) between the subcarriers
- Requires a more linear power amplifier.

RELATED WORKS

Krishna .N Chaudhari et.al, 2013[15] proposed MIMO-OFDM based channel equalization. Then obtained results are compared with MLSE equalizer. From the results it has been concluded that proposed equalizer reduces the BER rate.

NishaAchra et.al, 2013[16] proposed a work in which MIMO-OFDM performance has been measured with the two equalizers i.e. ZF and MMSE. Also they uses the three channels like AWGN, Rayleigh and Rician fading channels to implement the work.

Sandeep Kumar et.al, 2013[17] Studies the Performance Analysis of a General MIMO-OFDM System for Next Generation Communication Systems. Also it analyses various parameters like No. of antennas, modulation type, SNR, Pilot symbol etc.

AnshuJaiswal et.al, 2014[18] author proposes review paper that includes the concept of channel estimation in MIMO-OFDM systems. OFDM systems based on pilot based channel estimation technique. To improve the accuracy, reliability of the system, there is need to have sufficient knowledge about the channel estimation. To reduce the BER, use of Channel Estimation BPSK-QPSK-PSK 16 &64 is recommended in QAM MIMO-OFDM System.

Bhavin et.al, 2014[19] proposed the utilization of ZF and MMSE equalizers to measure the performance of MIMO and OFDM system over Rayleigh channel to improve the performance.

Dejin Kong, et.al, 2014, [20] propose two channel estimation schemes, i.e., linear minimum mean square error (LMMSE) and weighted least square (WLS), and we also derive their corresponding Bayesian Cramér-Rao Bound (BCRB) and Cramér-Rao Bound (CRB) bounds, respectively. Simulation results demonstrate that the BCRB and CRB bounds could be achieved by the proposed LMMSE and WLS methods, respectively. Moreover, simulation results show that the proposed methods are much robust to the time synchronization error compared to the conventional frequency domain methods, and imply that the pulse shaping filter with waveforms concentrated in the time domain could be employed in OQAM-OFDM systems to improve the channel estimation performance and spectral efficiency.

Pratima et.al, 2014 [21] presents channel estimation scheme based on Leaky Least Mean Square (LMS) algorithm proposed for BPSK-QPSK-PSK MIMO OFDM System. By designing this they analyses the terms of the Minimum Mean Squares Error (MMSE), and Bit Error Rate (BER) and improve Signal to Noise Ratio. This estimation is taken place on pilot arrangement.

Wang Liping,2014, [22] the author proposed the design of the completely orthogonal pilot data symbol among the different subcarriers position of different transmitting receiving antenna pair. And the pilot data symbols are distributed in the entire time-frequency grid of the channel reasonably, therefore this paper uses a FFT unit whose points are equal to the number of the OFDM subcarriers to realize the least-square channel estimation algorithm. In the process of channel estimation, the channel parameters estimation precision has increased because of the noise getting better inhibition, which reduces the least squares estimate noise sensitivity to the requirements.

VARIOUS OPTIMIZATION TECHNIQUES

Genetic Algorithm

Genetic Algorithms are adaptive heuristic search algorithm based on the evolutionary ideas of normal range and inheritance. As such they signify an intelligent operation of an arbitrary search used to solve optimization problems.

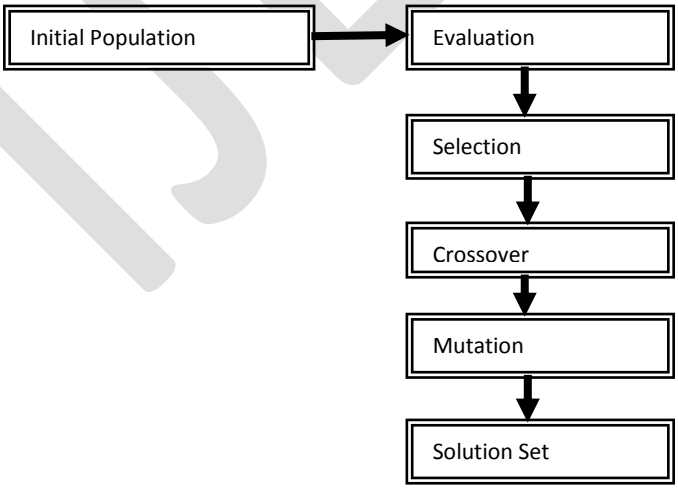


Figure 3 Genetic algorithm flowchart

Bacterial Foraging Optimization Algorithm

Bacteria Foraging Optimization algorithm is a new class of geographically confident stochastic international search technique based on mimic the foraging behavior of E. coli bacteria. This method is used for locate, handling, and ingesting the food. During foraging there can be risks due to predators, the prey may be mobile so it must be chased and the physiological characteristics of the forager constrain its capabilities and ultimate success. Bacterial Foraging optimization theory is explained by following steps.

- Chemotaxis
- Swarming
- Reproduction and
- Elimination-Dispersal

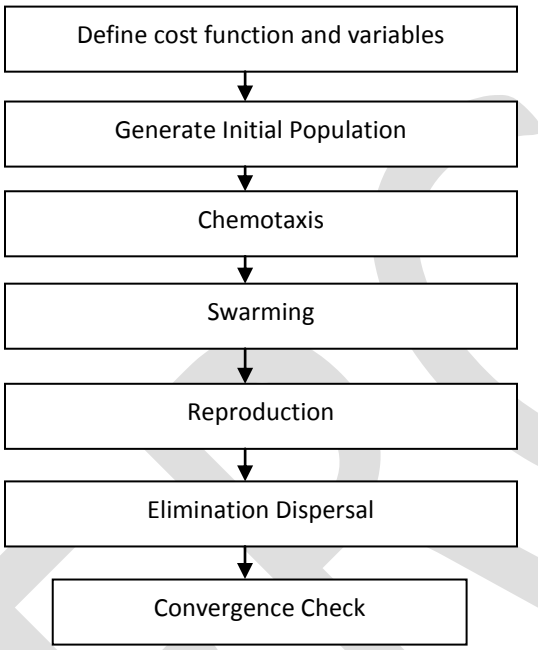


Figure 4 BFO Flowchart

CONCLUSION

These days large number of information is transmitted over communication systems. Mainly analog to digital and digital to analog links has been used these days. But modulation is very important step in communication systems. OFDM is one in which modulation takes place well. So this paper has presented various techniques like neural network, SVM and GA for optimizing the OFDM.

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