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An Overview of OFDM System using Pilot Aided Approach For Channel Estimation

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Abstract- OFDM system is a very spectacular technology which has a great tendency of offering high speed voice, audiovisual and data services to the clients. These facts have made OFDM system to achieve colossal attention worldwide for the upcoming generations of wireless communication. In OFDM systems' channel estimation is very essential in order to obtain an original signal after it is transmitted without being degraded. Channel estimation sets the basis for enormous researchers' in order to enhance the OFDM system as well as to get the information about the original signal or data. There are various methods available to carry out channel estimation efficiently. In this paper a discrete Fourier transform based pilot aided approach with the existing CEO has been proposed. Simulation is performed in terms of signal to noise ratio (SNR) and bit error rate (BER).

Keywords- OFDM, Channel Estimation, Fading, Pilot carrier.

1. INTRODUCTION

The rapid growth of high data rate transmission makes a need to improve the performance of a network. This can be made easy by using Orthogonal Frequency Division Multiplexing. OFDM is an approach in which the multicarrier transmission technique have been used for wireless communication. Here the high data rates are used to transmit the data or signal from the transmitter end to receiver end. This high data can be divided into various sequences of the data. These sequences can be concurrently transmitted by the sub carriers. The IEEE 802.11a includes the OFDM as a standard due to its robustness under multipath fading conditions [1].

2. OFDM TRANCIEVER

OFDM transceiver arrangement has been illustrated in the Figure-1. Afore transmitting bit stream from OFDM transmitter end over a particular channel, bits are first modulated using the different modulation schemes. By making use of modulation methods the transmitter unit styles the digital signal or data appropriate for transmission into a mapping unit. The task of serial to parallel convertor is the generation of multiple sub-carriers streams which are parallel to each other. After pilot insertion the spectral exemplification of the sub-carriers data is then send to IFFT. This results in the introduction of the orthogonality between multiple carriers. Then the cyclic prefix is added in order to remove the inter symbol interface and inter-carrier interference paraphernalia. Then the outcome from CP unit is again converted back to serial by using parallel to serial converter. Similarly the data is passed through different stages in the receiver end.

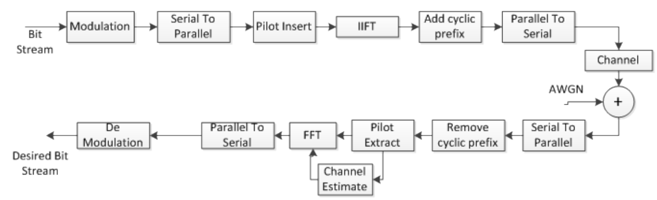

Figure-1: Block Diagram of OFDM Trans-Receiver

3. FADING

Fading spectacle take place in almost every wireless communication channels because the multiple signal or data paths are present which have a tendency to vary throughout the transmission process. There are voluminous modus operandi used for the compensation of fading channel misrepresentation. Rudimentary phenomenon of fading is enlightened in Figure 2.

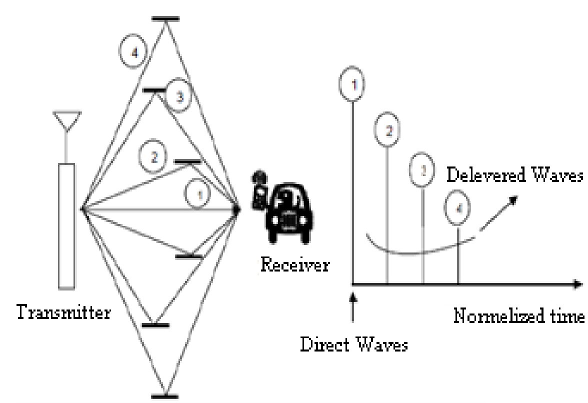

Figure-2: Multipath Fading Channel [2]

In a wireless communication system signal or data is transmitted from a transmitter end to a receiver end through the physical medium of channel. Errors are introduced in the channel causing noise or fading in the data being transported. Multipath fading is the cause of the positive and negative grouping of arbitrarily delayed, reflected, diffracted and smattered signal components. This form of fading is responsible for the short term signal variations as it is moderately faster than others. There are several models which defines the statistical performance of the multipath-fading envelope which is grounded on the radio wave propagation.

The Rayleigh and Ricean are most frequently used statistical models to epitomize small scale fading spectacle.

4. CHANNEL ESTIMATION

There are basically two issues while modelling channel estimators for wireless OFDM systems. The first delinquent deals with the organization of pilot statistics, where pilot refers to the reference signal which is utilized by both the transmitters and the receivers. The second delinquent deals with the design of a channel estimator that is less complex and has a respectable channel tracking aptitude. Both the two issues are interlinked to each other.

The channel for estimation of OFDM systems can be observed as a two- dimensional that is 2D signal. This is due to both time and frequency. The finest channel estimation can be done on the basis of mean-square error which ground on 2D Wiener filter interpolation [3]. A 2D estimator arrangement is excessively multifaceted for real-world implementation. OFDM systems demands the utilization of estimators which have low complexity as well as excellent precision to deliver high data rates along with low bit error rates. Therefore, the one-dimensional that is 1D channel estimations are frequently implemented in OFDM systems in order to succeed the trade-off between the complex nature and precision [4].

There are various channel estimation schemes available among them two simple 1D channel estimates are pilot aided block-type channel estimate and pilot aided comb-type channel estimate. The pilots are inserted in the frequency direction for first type estimate and in the time direction for the second type estimate. Pilot aided block-type scheme might be based on least square method abbreviated as LS, minimum mean-square error or MMSE and modified MMSE. Pilot aided comb-type scheme comprises the LS estimate along with 1D interpolation, the maximum likelihood estimator that is ML and lastly PCMB estimator that is the parametric channel modeling-based estimate. Supplementary channel estimation schemes were also premeditated [5–9] like the methods centered on basic 2D interpolations, iterative means of filtering and decoding etc.

5. LITERATURE REVIEW

This section presents the various methods established in order to improve the precision of channel estimation based on the existing relevant research work.

A sophisticated channel estimation scheme for OFDM wireless communication systems has been suggested in [10], in which channel estimation algorithm presented is grounded on a semi-blind low complexity frequency domain. There is enormous research works followed for channel estimation in the time domain. A joint data estimation algorithm is proposed, which makes a combined utilization of data and channel controls [11]. J. Lee et al. have presented a channel estimation scheme based on joint carrier frequency synchronization and the expectation-maximization approach [12]. A mutual frequency offset and channel estimation method for multi symbol encapsulation that is MSE OFDM system is suggested in [13]. Z. Zhang et.al have is presented subspace tracking [14]. The authors of [15] have suggested a sequential method grounded on carrier frequency offset and timing symbol estimates. Algorithm based on a pilot aided channel estimation in the manifestation of synchronous glitches by manipulating the prior existed information about the interference configuration is illustrated in [16] while in [17] implicit pilots for joint detection and estimation of channel are used. L. Zheng et. al have proposed [18] estimation for the channel which is based on spectral density of power and LS estimation for OFDM systems along with timing offsets. A combined time domain trailing of channel frequency offset for OFDM systems is proposed in [19] whereas a time sphere carrier frequency offset trailing method based on Particle filtering is obtained in [20]. Radial Basis Function grid based estimation of channel has been explored in [21]. The fading processes are demonstrated based on using the radial basis function grid.

6. PROPOSED APPROACH

A pilot aided DFT based interpolation is proposed in this paper for channel estimation in OFDM system. This technique also makes use of the existing cross entropy optimization methods in a way to insert pilot tones.

Figure 3, explains the proposed work. Firstly the OFDM signal (F) is passed and then Discrete Fourier transformation of signal as DFT (f) is performed. Pilot tones are inserted such that the result obtained can be represented as:

$$S_{OFDM}^{P_T} = DFT\ (S_{OFDM}) + P_T[i]_{i=0}^{x-1}$$

For each symbol of OFDM in frequency domain sparse channel offset tracking is done. The following equation describes the tracking:

$$\acute{\alpha} = \left(\frac{1}{2\pi T_{SUB}}\right) max(\alpha)$$

$$\left\{\sum_{j=0}^{l-1} p_{l+d}[a[j],\alpha]p_l^*[a[j],\alpha]q_{l+d}^*[a[j]]q_l[a[j]]\right.$$

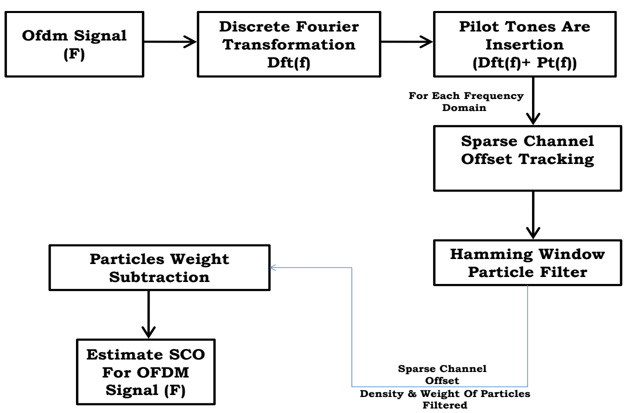

Figure 3: Block Diagram of Proposed Approach

Then Hamming window particle filter approach is used to set the boundary line. Sparse Channel offset, density and weight of particle are filtered. The equation can be represented as:

$$p(x_k|y_k) = \sum_{i=1}^{M} w_k^i \alpha(x_k - x_k^i\ )$$

Finally after subtracting the weight of particle sparse channel offset is done.

7. SIMULATION PARAMETERS

OFDM transceiver for sparse channel estimation is simulated using the MATLAB software. The simulation and design parameters are specified in the Table 1.

Table 1: Input parameters

Variable	Value	Description
len_fft	64	Size of the FFT
sub_car	256	Number of OFDM data sub-carriers
SNR	0 to 30	Range of SNR
Fd	200 Hz	Maximum Doppler Shift
H	Channel	Rayleigh fading channel

8. EXPERIMENTAL RESULTS

The performance of the proposed algorithm for sparse channel estimation in OFDM system is compared under the Rayleigh fading channel. Simulation is performed in terms of signal to noise ratio (SNR) and bit error rate (BER). First the performance of the various number of subcarrier is compared by varying the number of subcarriers from 120 to 768 as shown in Figure 4. It is clear from the graph that the minimum bit error rate is obtained when the number of subcarrier is 256.

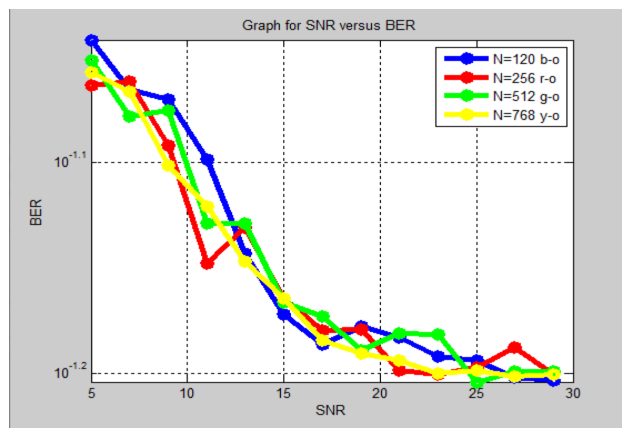

Figure 4: Comparison of BER for OFDM with variable number of subcarriers

The effect of Doppler shift on the OFDM system performance is compared by varying the Doppler shift frequency and plotting the BER curves as in the Figure 5. It is found that as the Doppler shift is increased the performance of BER reduces slowly. After the SNR of approximately 25 dB the BER approximately becomes constant with the increase in Doppler shifts. It is also cleared from the figure that the BER obtained at Doppler shifts 11.4, 50, 100 are moreover similar. Hence the Doppler shift is fixed to 11.4 Hz for further analysis. It is clear from the Figure 5 that up to SNR of approximately 16 DB lower Doppler shift gives better BER but at higher SNR of greater than 20 dB higher Doppler frequencies may be used.

The performance of the various QAM modulations is compared by varying the modulation order from 16 to 256 as shown in Figure 6. It is clear that increasing the modulation order not only expands the capacity of wireless system but also reduces the error probability. The lowermost bit error rate is attained at the modulation order of 256.

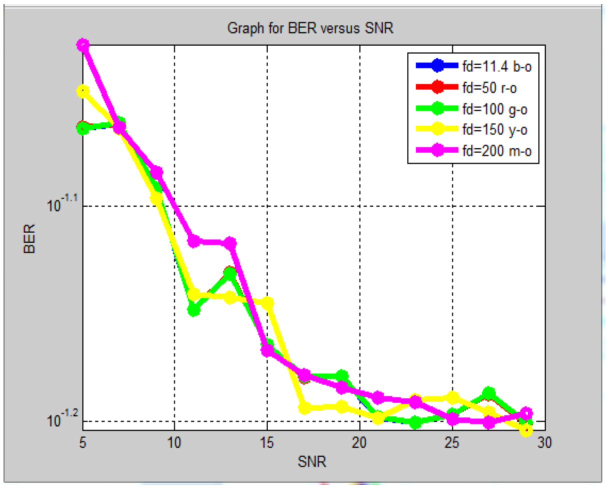

Figure 5: Comparison of BER for OFDM with different Doppler shift frequency

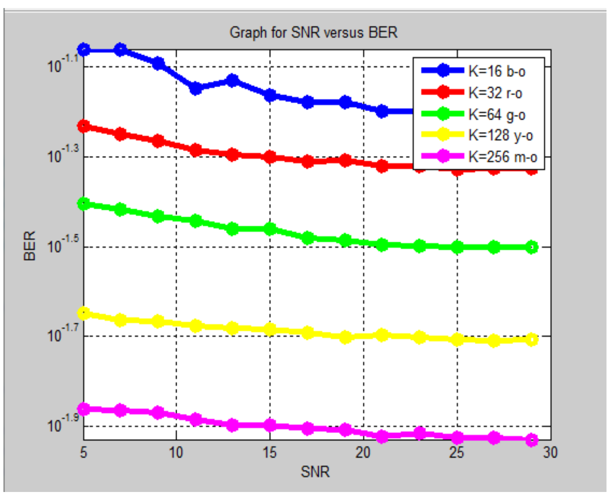

Figure 6: Comparison of BER for OFDM with different modulation order

9. CONCLUSION

In the paper, a pilot aided DFT based interpolation is proposed for SCO estimation. Pilot tone inset scheme for channel domain and transmission of every OFDM symbol for SCO trailing is done. Then Hamming window filter particle approach for approximation of the sparse channel offset (SCO) systems is applied. The performance evaluation of channel offset estimator using the multipath Rayleigh fading channels for OFDM system is presented. The performance is evaluated by varying the number of subcarriers, Doppler shift frequency and the modulation order. It is concluded that minimum BER is attained when the number of subcarriers taken are 256.

It is also detected that for lower range of SNR up to 16 dB the Doppler shift must be kept minimum. It is also found that the increasing the modulation order reduces the error rate.

In upcoming future channel offset estimator may be exploiting the periodicity entrenched in a training symbol and oversimplify the renowned correlation based approaches such that the estimation array of all the correlations entrenched in a training symbol can be prolonged to the maximum.

10. ACKNOWLEDGMENTS

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