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# Pilot Tone based Winner Filtering Approach for Carrier Channel Offset Estimation in OFDM Systems

**Shweta Sharma, Minal Saxena**
Department of Electronics and Communication
Sagar Institute of Research and Technology, RGTU, Bhopal, India

***Abstract* – OFDM is an approach in which the multicarrier transmission technique has been used for wireless communication. Here the high data rate has been use to transmit the data. This high data can be divided into various sequences of the data. However, OFDM is sensitive to the receiver synchronization errors such as carrier channel offset (CCO) that causes inter carrier interference (ICI), and exacerbated by motion-induced Doppler shifts and local oscillator instability. This paper proposes a solution that incorporates DFT Based Superimposed Pilot Aided approach with Winner Filter for Carrier Frequency Offset Estimation in OFDM Systems. Proposed methodology employs Winner filter for approximation of density and weight of filtered particles. Finally on the basis of weight of filter particles proposed system estimate CCO for OFDM signal. An analytic expression in form of mean square error (MSE) and SNR ratio of frequency offset synchronization is reported, and simulation results verify theoretical analysis and show approximate 1.99X improvements in MSE and 73% enhancement in SNR ratio.**

***Keywords* – OFDM, Channel Estimation, Carrier Frequency Offset.**

## I. INTRODUCTION

Broadcasting has allowed people to communicate without any physical connection to more than one hundred years. When Marconi was able to demonstrate technology for wireless transmission, for more than a century, was a breakthrough and the beginning of a new industry. There may be one cannot be called a mobile wireless system, but no wires! Today, advances in semiconductor technology possible, but he did not forget the reach of millions of people to communicate on the move all over the world.

In recent years, there has been an explosion in wireless technology. This growth has opened up a new dimension for wireless communications in the future, which is to provide a global multi-media personal contact with the ultimate goal, regardless of mobility or a place with high data rates. To achieve this goal, and personal communications networks, the next generation must be compatible with a wide range of services that include high-quality voice, data, fax, fixed and the flow of video images. It is likely that applications that require high-speed transfer of several large parts include in the second (Mbps) of these services in the future.

In the present scenario mobile communication systems has very popular and use to high bit rates data transmission for number of services. The services like video, audio and high quality mobile Integrated Services Digital Network. When the data transfer rates of high-bit, through radio channels portable, and can channel impulse response extends over several periods of code, which leads to interference intersymbol (ISI). Orthogonal Frequency Division Multiplexing (OFDM) is one of the candidates promising to mitigate the ISI. In OFDM divided bandwidth signal to many sub-channels narrow transmitted in parallel. Are selected each sub channel usually narrow enough to eliminate the effect of the spread of delay. By combining OFDM with turbo coding and antenna diversity, and link budget constraints and cellular mobile radio environment can overcome the distractions fade / Co / can reduce interference and channel effects.

Today OFDM is the most emerging communication technique for the purpose of wireless transmission at a very high speed. This is because of its enormous advantages. Its main advantages are less bandwidth requirement and a phenomenal performance in frequency selective channels [1], [2], [14]. But, one of its limitations is the sensitivity towards frequency differences which may be due to the Doppler shift and/or mismatch between frequencies generated by the oscillators at the transmitter and receiver [1]. These reasons cause the frequency offset among the subcarriers and distorts the relation of orthogonality between them and the result is inter-carrier interference (ICI) [15].

## II. ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING

Orthogonal Frequency Division Multiplexing [1] has proved (OFDM) suitable for high data rate modulation technique in time-dispersive channels [2]. There are some specific requirements in the design of wireless OFDM systems, for example, the choice of the bandwidth of subcontractors / channels used to move and how to achieve reliable synchronization. The latter is especially in the packages / base systems of the importance of synchronization has to be achieved within a few symbols.

To get excellent output of the receiver end, there is a need to know the impact of the channel. The problem is how to extract this information in an effective manner. Traditionally, the multiplier is known symbols in the data flow for channel estimation. Of these codes, and appreciates all the decay channel using interpolation filter.

Channel estimation [3] has a extensive and rich history in the communications systems and one carrier. In these systems, usually modeled as CIR varying FIR unknown candidate in a timely manner, and should be estimated coefficients. Many approaches can be applied to individual channel carrier systems for multiple carrier systems appreciated. However, the unique properties of the transfer of multi-carrier achieve additional views allow for the development of new methods for the direct estimation multi-carrier systems. In existing systems OFDM, and modulated data on Orthogonal Frequency companies. For the detection of coherent data transferred, should these responses are estimated frequency sub-channel and removed from the frequency samples. As is the case in a single carrier systems, can channel time domain formed as a FIR filter, where it can estimate the delays and transactions from time domain received samples, which are then transformed into the frequency domain to obtain and CFR. Instead, the radio channel can also be estimated in the frequency domain using the well-known (or disclosure) sub-frequency domain data channel. Instead of estimating FIR coefficients can be estimated faucet CFR [5,6].

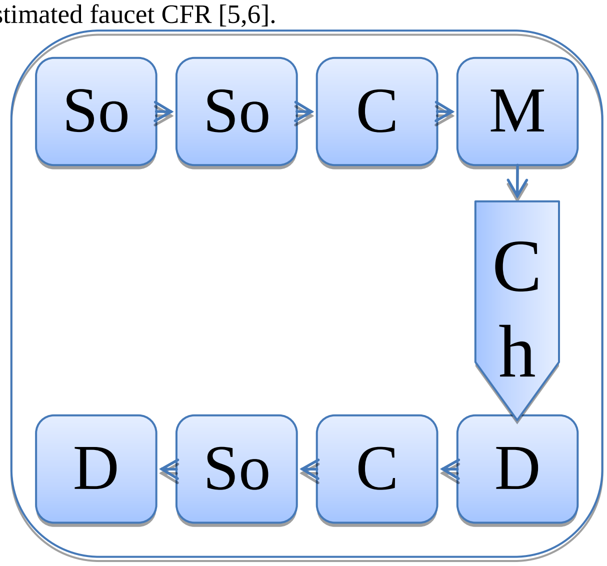


Fig.1. FunctionalBlockinaCommunicationSystem

The techniques [7,8] can be classified channel estimation OFDM systems based on two main categories: the blind and not blind. Blind methods exploit the statistical behavior of the channel estimate signals contained and requires a large amount of data. Therefore suffer severe performance degradation in fading channels quickly. Moreover, in the ways of the channel estimate is blind, information is available from previous estimates of the channel or a portion of the transmitted signal to the receiver to be used in the estimation of the channel.

## III. Channel Estimation Methods

Channel estimation [9,10,11,12] has a extensive and rich history in the communications systems and one carrier. In these systems, usually modeled as CIR varying FIR unknown candidate in a timely manner, and should be estimated coefficients. Many approaches can be applied to individual channel carrier systems for multiple carrier systems appreciated. However, the unique properties of the transfer of multi-carrier achieve additional views allow for the development of new methods for the direct estimation multi-carrier systems.

Channel estimation methods based on the pilot insertion can be divided into two classical pilot models, which are block-type and comb-type model. The first model refers to that the pilots are inserted into all the subcarriers of one OFDM symbol with a certain period. The block-type can be adopted for slowly fading channel, that is, the channel can be considered as stationary within a certain period of OFDM symbols. Nevertheless, the second model refers to that the pilots are positioned at some definite subcarriers in each OFDM symbol [13,14l.

## IV. Related Work

In [1] author proposed IAFA-CE system which investigate the intrinsic interference caused by intra-symbol data and channel noise in the intensity-modulation direct-detection OQAM–OFDM (IMDD–OQAM–OFDM) system by theoretical derivation. IAFA-CE considering the intrinsic interference and channel noise on OQAM–OFDM system. This algorithm can achieve high accuracy CE for combating the system noise. The 10 Gb/s IMDD–OQAM–OFDM system is set to validate the algorithm. The algorithm can greatly reduce EVM. IAFA-CE can achieve ~1.5 dB sensitivity improvement compared with IAM-C.

In [2] author present a novel approach for pilot-aided channel estimation in OFDM systems with synchronous co-channel interference. The estimator is derived based on the Kullback-Leibler divergence minimization framework. The obtained solution iteratively updates both the desired user's and the interferer's channels, using a combination of linear minimum mean squared-error (LMMSE) filtering and interference cancellation, avoiding the complex matrix inversions involved in the full LMMSE channel estimation approach. Estimation of the noise variance is also included in the iterative algorithm, accounting for Gaussian noise and residual interference after each iteration. The estimates of both channels are used at the equalizer to reject the interfering signal, thus mitigating the degradation due to co-

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channel interference. Simulation results show that the receiver using the proposed estimator performs as good as the one employing the full LMMSE estimator and very closely to a receiver having perfect knowledge of the channel coefficients.

In [3] a novel, reduced complexity iterative channel estimation algorithm for OFDM systems using superimposed pilots is proposed. It utilizes past channel estimations of double correlated channel as a side information to reduce number of iterations. In this paper, Least Square (LS) channel estimation followed by two dimensional Wiener filter for reducing OFDM symbol interference is done iteratively to achieve the Minimum Mean Square Error (MMSE). Small variations of the channel over each OFDM symbol duration are neglected due to a high data rate, but the values between different OFDM symbols are assumed correlated. The channel is modeled as a double selective, i.e. both frequency selectivity channel and Doppler shift are taken into consideration. Past channel estimates are used as side information for the present channel estimation to improve the forthcoming channel estimation at the first iteration and reduce the total number of iterations required.

In [4] author describe orthogonal Frequency Division Multiplexing (OFDM) is multiplexing technology of orthogonal multi-carrier, and the channel estimation model based on pilot in OFDM systems is analyzed; Now that, the channel estimation based on pilot needs interpolation, in order to reduce the complexity of the interpolation algorithm, the FFT channel estimation algorithm based on pilot is studied. Because of the direct FFT channel estimation algorithm existing energy spectrum leakage problems, the optimized FFT channel estimation algorithm based on the Hamming windowed function is put forward. The simulation results show that in the multi-path fading channel, the proposed algorithm can effectively improve performance of channel estimation in OFDM systems.

This paper [5] investigates the pilot placement problem for sparse channel estimation in orthogonal frequency division multiplexing (OFDM) systems. Prompted by the success of the compressed sensing technique in recovering sparse signals from under sampled measurements, compressed sensing has been successfully applied for pilot-aided sparse channel estimation in OFDM systems to reduce the transmitted overhead. However, the selection of pilot tones significantly affects channel estimation performance. Seeking optimal pilot placement for sparse channel estimation, in the sense of minimum mean-square error of the channel estimation, through an exhaustive search of all possible pilot placements is extremely computationally intensive. To reduce the computational complexity and simultaneously maximize the accuracy of sparse channel estimation, cross-entropy optimization is introduced to determine the optimal pilot placement. Computer simulation results demonstrate that the pilot index sequences obtained using the proposed method performed better compared with those obtained using the conventional equispaced scheme and the random search method.

An Efficient Pilot Design Scheme for Sparse Channel Estimation in OFDM Systems having higher signal to noise ratio, bit error rate and having energy spectrum leakage problem so there is need of an scheme which overcome all this problem.

## V. PROPOSED METHODOLOGY

In CCO estimation by using frequency domain involve the assessment of each phase of the carrier for each symbol in the following, the symbol in the phase shift due to the carrier Channel offset. Two different evaluation methods to estimate CCO estimation method based on the pilot is used, which is the acquisition and tracking mode. In the acquisition CCO estimation method is powerful and made the tracking mode is estimated that the fine CCO. Initially, it is assumed that the estimated purchase has already been done so well and CCO estimation is made in this paper. All simulation results show the mean square error (MSE) with respect to different signal-to-noise ratio (SNR) in dB and learning with respect to a ratio of the length of the OFDM symbol sequence of the repeat sequence respect to various CCO values.

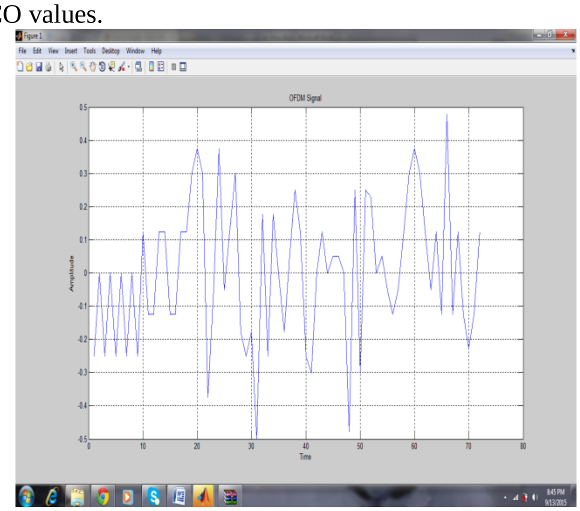


Fig.2. OFDM Signal

Winner Filtering Approach for Carrier Frequency Offset Estimation in OFDM Systems having particle impoverishment problem ie particles having higher weight statistically selected many times which is inappropriate for performance enhancement.

Particle impoverishment problem over OFDM means statistically selecting higher weight particles many times which is inappropriate for performance enhancement. Winner Particle Filtering Approach for Carrier Channel

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Offset Estimation in OFDM have particle impoverishment problem which degrade the performance.

In order to overcome Particle impoverishment problem, this dissertation propose a solution that incorporate DFT Based Superimposed Pilot Aided approach with Winner Filter for Carrier channel Offset Estimation in OFDM Systems in order to detain particle impoverishment problem.

Proposed methodology for Channel estimation initially takes OFDM spectrum of N sub channel as show in equation.

$$S_n(t) = \frac{1}{N}\sum_{n=0}^{n-1} A_n(t)e^{j|\omega_n^t + \theta_n^t|}$$

Where $S_n(t)$ is OFDM spectrum of N sub channel and An (t) is amplitude and $\theta_n(t)$ represent phase of the carrier..

After that proposed methodology apply DFT over OFDM signal for fragment out different channel separately. Then generate auto covariance matrix for these fragmented channel. Apart from that proposed methodology subsequently take equivalent pilot tone signal $P_m(t)$ and generate auto covariance matrix for it.

After generation of covariance matrix for both OFDM and Pilot tone signal proposed methodology perform comb- type pilot tone insertion. Diagonal element of covariance matrix of Pilot tone signal is to be inserted at diagonal element of covariance matrix of OFDM signal. This insertion lead lower noise generation in OFDM signals.

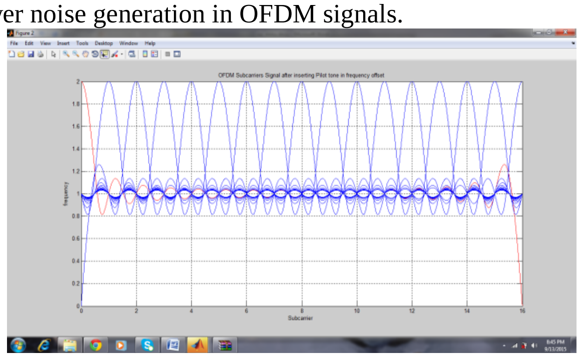

Fig.3. Channel offset with pilot tone for Signal

Furthermore after pilot tone insertion Winner filter employed for approximation of the density of particles filtered and weight. Finally on the basis of filter particles weight proposed system estimated CFO for OFDM signal.

Then filter particles approach Winner Filtering (WF) to estimate the carrier channel offset (CCO) systems.PF in OFDM is stronger especially for nonlinear problems where traditional approaches like maximum likelihood estimators cannot show the best performance. PF suffers the problem of reducing the standard particles (PI) due to re-sampling the static parameter (ie CCO) estimation. Winner PF (GPF) inhibits IP problem because the process of re-sampling is not required in the algorithm.

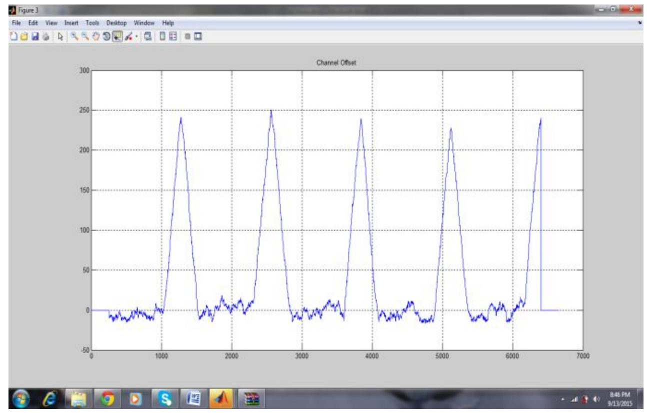

Fig.4. Channel offset estimation for Signal

The Winner Filtering approximates filtration and predictive Gaussian densities on a frame PF. The Winner Filtering updated recursively as posterior mean and covariance of the parameter of interest (ie CCO). The basic idea is to represent a PF density (for example filtering or higher density) samples generated and their associated weights. Then approximate particle density filtration and weight is displayed. The approximation of the density of particles filtered and weight as

$$p(x_k|y_k) = \sum_{i=1}^{M} w_k^i \, \alpha(x_k - x_k^i)\ldots\ldots\ldots..3 \qquad (11)$$

Where i represent particle and k represent its time index whereas M denote total particle number. Then on the basis of that particles weight proposed approach estimate CCO for channel offset as show in figure 4 that represent estimated channel and frequency offset respectively.

## VI. SIMULATION AND PERFORMANCE EVALUATION

To simulate the proposed work the implementation has done in MATLAB. The execution has been done on the i3 processor with 4 GB RAM and 500 GB HDD. The Signal processing used in communication system pay focus on fetching the raw signal for getting information the complexity can be enhance with respect to signal by its characteristics. The SNR or signal-to-noise-ratio represents the strength of the signal and noise. When this ratio gets higher than the extracted information is more reliable

$$Mean = \bar{x}/s$$

Where $\bar{x} = MEAN$

S-= Standard Deviation

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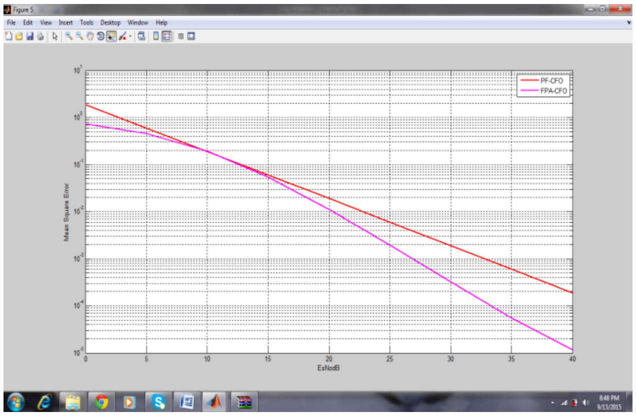

Fig.7. Comparison of MSE

It is a general term, which in computer network and communication system is measure of how much true signal versus how much noise. It is a particular image has, which results in a grainy appearance.

$$SNR = \frac{Ps}{PN}$$

Where Ps is signal power and PN is noise power

Along with that SNR ratio is also being compared as show in figure 8.

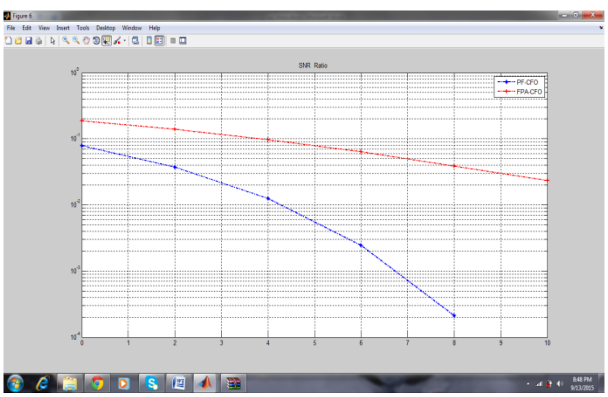

Fig.8. Comparison of SNR Ratio

The signal to noise ratio can calculated as per formula given above. In figure 8 the Results of both methodology and it seems to be that the 73% improved SNR has been calculated by the proposed approach.

## VII. Conclusion

OFDM is an emerging field in the world of wireless communication. In this way there are lots of challenges in front of us. This dissertation gives a brief description on the OFDM and their issues. It also explore problem faced in the channel offset estimation over OFDM. In order to overcome energy spectrum leakage problem in this paper proposed solution incorporate DFT Based Superimposed Pilot Aided approach with Winner Filter for Carrier channel Offset Estimation in OFDM Systems.Proposed methodology employs Winner filter for approximating the density and weight of filtered particles. Finally on the basis of weight of filter particles proposed system estimated CCO for OFDM signal. Superimposed Pilot Aided approach have much more less MSE and SNR than existing sparse channel offset estimation based approach .Which is nearly 73 % improvement in SNR and 1.99X improvement in MSE. In future frequency offset estimator may be utilizing the periodicity embedded in a training symbol and generalize the well known correlation-based methods such that the estimation range of all the correlations embedded in a training symbol can be extended to the maximum.

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