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An Efficient Multiuser Interference Cancellation Scheme for OFDMA Systems Using Frequency Offset Correction

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***Abstract*: An interleaved OFDMA framework with carrier frequency offset (CFO) correction plan is implemented. The past recommendations for OFDMA adjusting for the CFO impact at the OFDMA recipient can stay numerous access impedance In our project carrier offset correction plans have been proposed to relieve the interference impact, we found that the minimum mean square error (MMSE) execution of demodulated signs is identified with a typical corrected CFO (CCFO) esteem which was redressed using discrete time fourier transformation DTFT. In this paper we investigate a versatile CCFO rectification conspires and assess the execution of the interleaved OFDMA collector using the new CCFO algorithm to attain to the ideal MSE execution. Simulation results demonstrate that the past recommendations for OFDMA in conjunction with the new CCFO redress calculation can have preferable execution over their unique proposition in interleaved OFDMA frameworks.**

Keywords: **OFDMA, framework, (CFO), CCFO, carrier.**

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is an attractive transmission scheme used in WLANS. In OFDM downlinks, the available spectrum is divided into several orthogonal sub bands so that each narrowband experiences almost flat offset estimation allowing sub channels in the frequency domain thus increasing the transmission rate [1]-[2]. Frequency division multiple access (FDMA) method that assigns sets of subcarriers to different users has been a popular basic multiple access scheme for OFDM. This technique is called as Orthogonal Frequency Division Multiple Access (OFDMA). In OFDMA downlinks, distinct sub-carriers are assigned to different users for simultaneous transmission. Multiple users share the bandwidth simultaneously. Hence the users and the base station in the OFDMA downlink are required to be synchronous in frequency domain.

In the uplink of the OFDMA downlinks, offsets in the frequency assigned between users occur whenever their local oscillators are misadjusted and/or due to a frequency shift in their carrier frequency in offset estimation channels. This offset is called carrier frequency offset (CFO). CFO introduces not only inter-carrier and intersymbol interference but also multiple user interference between the users in the uplink of the OFDMA downlink [1]-[2]. In this paper, aIDTFT based multiuser interference cancellation scheme has been proposed for OFDMA downlinks.

Recent literature addresses the issue of multiuser interference in the uplink of OFDMA downlinks due to other user carrier frequency offset. The first method of uplink CFP

compensation is to estimate the CFO values and give them as feedback to the transmitter so as to enable it to adjust the transmitter frequency [6]-[7]. However this feedback requires additional signaling.

Interference cancellations at the base station receiver to cancel the CFO in the frequency domain were also studied [8]-[10]. The methods of interference cancellation involve the channel estimation of multiuser interference due to CFO and then cancel it form the desired users' signal [8]-[9]. A weighted Interference cancellation technique is proposed in [10] where the basic principle is to estimate the interference and to multiply the optimized weights and then subtract it from the required users' signal. However in this method, the weights are not decoder. Hence the performance of this technique is poor when the CFO is high.

In this paper, aIDTFT based multiuser interference cancellation has been proposed for OFDMA downlinks where the interference is weighted by decoder depending the characteristics of the mobile channels. Matlab simulations have been run with 95% confidence interval. Simulations have been carried out to simulate the Bit Error Rate (BER) performance of the proposed scheme in AWGN and Rayleigh offset estimation channels. It has been found from the simulations that BER performance of the proposed scheme is better than that of the multiuser interference schemes available in the literature.

The paper is organized as follows: We start with basic discrete model Section 2. We present aIDTFT based cancellation scheme in Section 3. Simulation results are presented and are discussed in Section 4. Conclusion and future extensions are given in Section 5.

II. DOWNLINK MODEL

We consider the uplink of an OFDMA downlink. It is assumed that there are N subcarriers in each OFDM symbol and one carrier is allocated to only one user [1]-[2]. Distinct sub-carriers are assigned to distinct users for simultaneous transmission. The uplink consists of K users. The data of each user in the frequency domain is converted to time domain by taking IDFT on the input. Then guard interval is added to the time domain samples. The time domain sequence of the i^{th} user on the k^{th} subcarrier is given by

$$x_n^{(i)} = \frac{1}{N}\sum_{k\in B_i} X_k^{(i)} e^{\frac{j2\pi nk}{N}}, \quad -N_G \le n \le N-1 \qquad (1)$$

where Bi is the set of subcarriers allotted to each of the users in the downlink and NG is guard interval length. This interval is assumed to be longer than the maximum delay spread of the channel. Let h(n) denote the impulse response of the frequency selective offset estimation channel. The time domain sequence of the ith user after passing through the channel is given by the residual functions available through protocol

$$z_n^{(i)} = r_n e^{\frac{-j2\pi n \varepsilon_i}{N}}, \quad 0\le n\le N-1$$

The received signal at the base station with CFO is given by

where ε_i, i=1,….K denotes the ith users' residual CFO and an is the AWGN with zero mean and variance σ^2 . CFO compensation in the time domain is done by multiplying the received signal by the CFO compensation value given by

$$Z_k^{(i)} = H_k^{(i)} X_k^{(i)} + \sum_{\substack{l=1 \\ l\ne i}}^{K} \sum_{q\in B_i} \rho_{kq}^{(i),(l)} H_q^{(l)} X_q^{(l)} + a_k^{(i)}$$

where

$$\rho_k^{(i)} = \frac{\sin \pi(k - q + \delta_{li})}{N \sin \frac{\pi}{N}(k - q + \delta_{li})} e^{-j(1-1/N)\pi}$$

The guard interval is removed and then DFT is performed to get the put in the frequency domain. The output of the DFT block corresponding to the ith user on the kth subcarrier is given by [7]

The first term in the equation (5) is the desired signal, the second term is the multi-user interference due to CFO and the third term is the noise term. This interference called the multiuser interference can be cancelled to get the desired users signal using many interference cancellation techniques [8]-[10]. In this paper, aIDTFT based multi-user interference cancellation has been proposed for OFDMA downlinks.

III. PROPOSED INTERFERENCE CANCELLATION TECHNIQUE

The performance of the uplink of the OFDMA downlinks is severely degraded when the different carrier frequency offsets occur. The offset of the desired user can be compensated but the offset of the others users' carriers are always misaligned and the interference due to this

$$\delta li \,\square\, \varepsilon l - \varepsilon i$$

misalignment affects the reception. Offset compensation of all the users at the base station is not possible because of the complexity involved in this process. CFO compensation in frequency domain without interference cancellation has been proposed but when the interference due to CFO offset is very large, the performance is affected by the interference [6].

Many linear and nonlinear multiuser detectors have been proposed to alleviate the multiuser interference in CDMA downlinks [3]. Parallel Interference Cancellation (PIC)is one of the schemes for canceling the multiple access interference. In this scheme, the interference is removed simultaneously from each user's received signal. Another promising suboptimal detector with acceptable delay is the partial parallel interference cancellation (PPIC). With this receiver, only part of the previously estimated signalremoved from the received signal input to the next stage [3]. The performance is better when the interference is weighted and then removed from the desired users' signal. Interference Cancellation schemes have been already proposed to counteract the interference due to multipath propagation or frequency offset in OFDM downlinks, but for single user or broadcast applications [8]-[10]. The cancellation is performed to remove the interference due to the others carriers of the same user, affected by the same frequency offset [8]-[9]. Weighted interference cancellation was proposed where the interference due to the CFO was estimated, weighted and then removed from the previous stage output of the receiver to recover the desired users' signal [10]. However in this paper the weights are decoder and hence the performance of this downlink is severely degraded by the offset estimation channel characteristics.

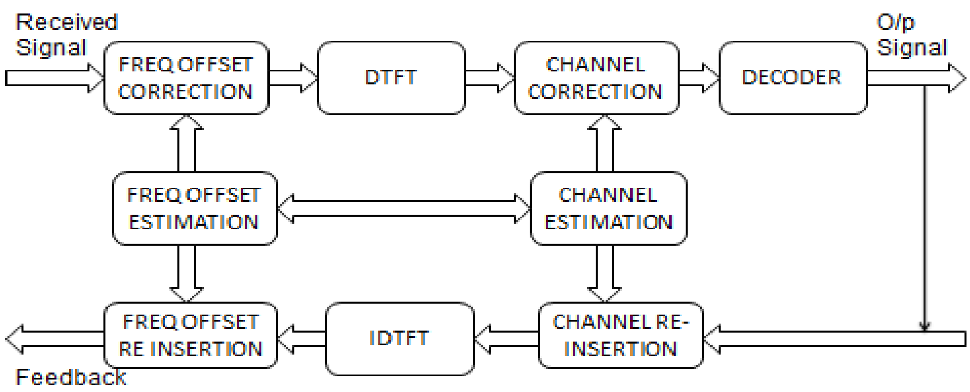

Figure 1 System model based on DTFT

IDTFT Based (figure 1)Interference cancellation receiver(FBIC) is a multistage detector in which the cancellation weights are not constant but decoderly obtained from IDTFT Inference Downlink () based on the principle of IDTFT logic. As the interference or the back ground noise increases, the performance of the uplink of the OFDMA downlink becomes worse. So the cancellation weight should be set to a small value. However, if the interference due CFO discrete weight should be set to a large value. Hence the optimal weight becomes larger as the number of users K decreases. The optimal weight obtained from is related to the number of users K and Energy to Noise density ratio (Eb/No) of each user. The amount of multiple user interference depends on the total CFO values of all interferers.

decoderly based on the number of users and CFO values of the users, the BER performance of the downlink can be greatly improved.

The IDTFT inference downlink is a decision-making logic that uses a set of DTFT IF-THEN values. The optimal weights are determined byDTFTvalues. These DTFTvalues are formed by matching input-output pairs through andecoder procedure. Five and Six Channel reselection membership functions are chosen to cover the universe ofdiscourse of two inputs $D_{eff,i}$ and Eb/No_i and one output weight λ_i, respectively shown in Table I. Five linguistic terms,negative low (NEL), zero (ZE), positive low (POL), positive medium (POM), positive high (POH), are chosen to cover the universe of discourse of the Eb/No of the desired user. Five terms very few (VEF), few (FE), medium (MED), many (MA), great many (GMA), are chosen to cover the universe of discourse for the effective number of users. Six terms almost zero (AZ), small (S), medium (MED), large (L), very large (VL), and almost one (AO), are chosen to cover the discourse of cancellation weights.

TABLE I Rule Base for

Eb/No	Deff VEF	FE	MED	MA	GMA
NEL	MED	S	AZ	AZ	AZ
ZE	L	MED	S	S	AZ
POL	ONE	L	MED	S	AZ
POM	ONE	VL	L	MED	AZ
POH	ONE	VL	L	MED	S

The Channel reselection membership function of the IDTFT set Fi in each interval [Ci-, Cj+] of the universe of discourse can be expressed in terms of a and b.

where a=1,2,3,4,5 and b=1,2,3. x_b takes values in the interval [Ci-, Cj+]. x_b^a and σ_b are the mean and the standard deviation of the Channel reselection membership function. The IDTFT control values of a two input- single output IDTFTdownlink are framed as

R j : IF Eb/No_i is F_2 a1 AND

Deff,i is F_2 a2 , THEN $\lambda_k = F_3$ a3

where F_2 a1 , F_2 a2 and F_2 a3 are the linguistic terms of the input variables $Ueff_{,i}$ and Eb/No_i and the output variable λ_i respectively. a1 ,a2 =1,2,3,4,5 a3 = 1,2,3,4,5,6 and the index of rule j = 1,2,…………25. The channel correction method is by centroid calculation. Thus the decoder principle of determining the partial weights can be followed for a multistage FBIC detector for interference cancellation. The optimal cancellation weights of the latter stages should be larger than those of the front stages.

IV. RESULTS AND DISCUSSION

Matlab simulations have been run with a confidence interval of 95% to compare the performance of the OFDMA downlink with the proposed interference cancellation with decoder weights. The following parameters are chosen for the downlink simulation. The number of subcarriers N=128, Number of users K=16, SNR = 20 dB, CFO values for the users are [0.13 0.24 0.65 0.34 -1 - 0.25 0.25 -0.13 -0.12 -0.23 0.54 0.23 -1 0.24 0.65 -1] from [8]-[10]. AWGN is assumed to have zero mean and unit variance. 2 stages of interference cancellation are performed. A two ray Rayleigh offset estimation(figure 2) channel is considered.

Fig.3 and Fig.4 show the BER performance of the uplink of the OFDMA downlink with 16 users and CFO values in AWGN and Rayleigh offset estimation channels. It is seen from the figures, that Single user detection (SUD) has the highest BER because of the no compensation and very high interference. The second method is CLJL method (CLJL stands Choi, Lee,Jung and Lee [6]) uses circular convolution method [6]. Thismethod uses only CFO compensation in the frequency domain but no interference cancellation. The BER performance using this method is better than that of the SUD because of the CFO compensation in the frequency domain. However it shows poor performance compared to that of the HLCC method [8]-[9] which employs both CFO compensation and interference cancellation. Our proposed method of interference cancellation shows better BER performance compared to the methods available in the literature due to the reason that here both CFO compensation and decoder cancellation are employed. The complexity of the proposed detector depends on the number of stages and the number of users. As the number of stage and number of users increase, the complexity in computations raises like all the other detectors in the literature. The simulation results have been presented for 2 stages. However it is observed that as the number of stages is increased, the BER performance is almost constant after 8 stages. This is because the interference after being cancelled in each stage, it becomes less and hence BER is constant without much change in its value.

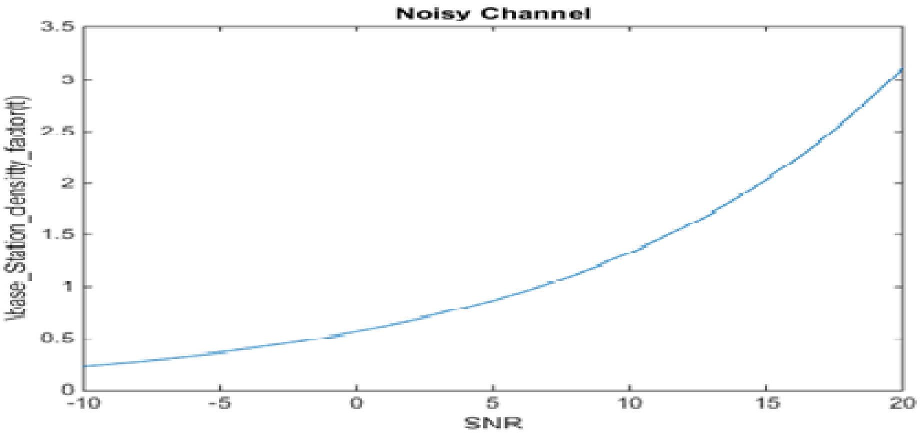

Fig2. creating a noisy channel

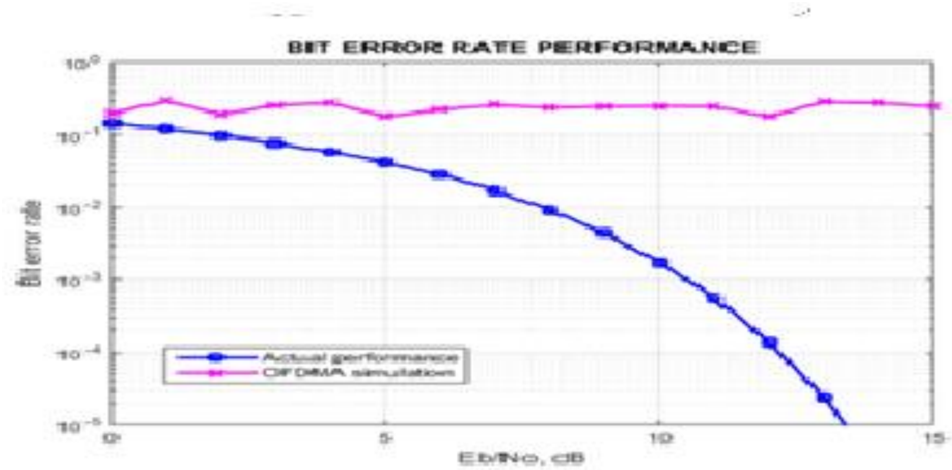

Fig.3 BER performance

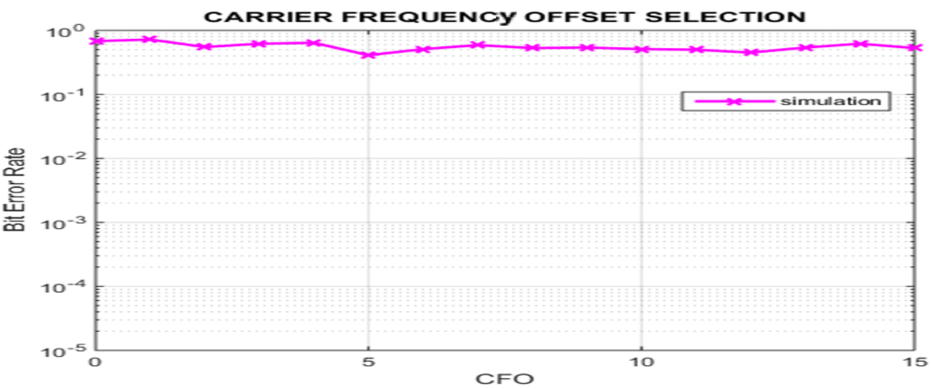

Fig.4 Selection of CFO

The proposed interference cancellation technique tested with image, voice and data as the input signal for each of the users in Rayleigh offset estimation channel with 32, 64 and 128 users. Fig.3 shows the BER performance of the proposed technique with image, voice and data as the input signal for each of the users in Rayleigh offset estimation channel with 32, 64 and 128 users. It is seen from Figure.3 that when the number users is increased from 32 to 128, the BER increases because the interference due to CFO increases as the number of users increases.

V. CONCLUSION

In this paper, an decoder weighted MUI cancellation technique has been proposed for OFDMA downlinks where decoder weights chosen to cancel the interference due to carrier frequency offsets depending the mobility characteristics of the mobile channels. Simulations have been carried out to simulate the Bit Error Rate (BER) performance of the proposed scheme in Rayleigh offset estimation channels. It has found from the simulations that BER performance is better that that of the proposed schemes available in the literature. The performance analysis of the proposed method with channel coding may be carried out as future work.

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