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OFDM CHANNEL ESTIMATOR USING KALMAN AND WEINER FILTER

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Abstract: Tremendous progress has been made on the past years on channel estimation in ofdm systems still it is considered as area of concern in wireless communication. A novel channel estimation technique with virtual sub carriers is proposed in this work namely a low-complexity but near-optimal DFT channel estimator with leakage nulling is proposed for OFDM systems utilizing virtual subcarriers. The flow of the expected act is initially commences mutually time-domain (TD) index exist estimation over the leakage effect before followed by low-complexity TD post-processing to control the leakage. The coming channel estimator act outperforms the subsisting channel estimators in doubt of efficiency and performance. Determinately the show and involution of the proposed algorithm are analyzed by simulation results.

KEYWORDS: OFDM, Channel estimation, Time domain, Wireless communications

I. INTRODUCTION

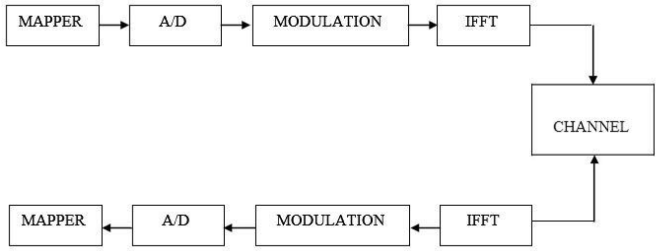
Orthogonal frequency division multiplexing (OFDM) is an efficient modulation scheme for broadband wireless communications. To obtain valuable data rates, certain channel approximation is required. With the moderately high demand for wireless communication systems, the rate and frequency Spectrum resources are constantly strained and the requirements of the wireless communication system spectral efficiency constantly high. Here we use OFDM because of its high resistance to multipath fading characteristics as readily as preferably High spectral efficiency of a ample number of applications. Meanwhile, with the multi-antenna Application of the program spectral efficiency has been greatly improved. MIMO and OFDM technology accordingly can significantly recover the spectrum utilization and transmission rate, many scholars and research in the next-generation wireless communication systems will be mostly used. Orthogonal frequency division multiplexing (OFDM) is an efficient modulation scheme for broadband wireless communications. To obtain high data rates, accurate channel estimation is required. Wireless computer network are broadly relegated facing three diverse categories namely i) Conventional parcel systems a well known as FDMA, TDMA which especially has two drawbacks such is peaceful data outlay and silent spectral efficiency. ii) Subsisting parcel systems gat a charge out of CDMA are opportune for on the wing and homing device communication notwithstanding the main stone in one path is data outlay (speed). iii) Future copulation communication models a well known as OFDM are utilized in Applications like 3G, 4G, LTE, WIFI, and WIMAX.Orthogonal frequency division multiplexing is about to be as highly helpful communication model compares to acknowledged communication models seeing of silent sensitivity to multipath propagation and important spectral efficiency. Orthogonal frequency division multiplexing also suffers from small number drawbacks, valuable peak to average capacity ratio is main difficulty which occurs discipline to the insufficiency a way with distribution by high power amplifier which get in-band and out-band distortion. Digital communication are comprised of two communication representations get by band representation and base band representation, get by band represents ongoing style of communication at the same time base band represents digital mode of communication. In our proposed field we disclose the base band representation of OFDM signal by all of N sub carriers as follows

$$x(t) = \frac{1}{\sqrt{N}} \sum_{k=0}^{N-1} X_k e^{j2\pi \frac{k}{Nt_s} t}, \qquad 0 \le t \le Nt_s \quad (2.1)$$

N represents number of sub carriers t_s=Sampling time
X represents the frequency domain of orthogonal frequency division multiplexing symbols such as $X=[X_1, X2\ldots\ldots\ldots X_{N-1}]^T$
T=Nts =symbol duration.
When the location of sub carriers is large before it can be treated as complex Gaussian process by the central limit theorem, this complex Gaussian process technically called as Peak to average power ratio. In term to renovate this issue several theories are expected in the literature. One of such theory practically in the literature is µ-law Companding; it reduces the Peak to average power ratio impact on orthogonal frequency division multiplexing in low amount.Orthogonal frequency division multiplexing (OFDM) has been attracted many research organizations related to high speed communication area due to its many attractive features like Orthogonality, acceptable to all types of scenarios like SISO, MIMO, MISO AND SIMO, no inter carrier interference and on the other hand it has so many drawbacks namely delay, distortion and finally peak to average power ratio.

II. LEAST SQUARE ESTIMATION

Channel estimate is done by inserting pilot symbols in both head and frequency domain. These pilot symbols extend an estimate of channel at unassailable locations within a subframe. Through interpolation campaign it is convenient to work out the channel contrary to an arbitrary number of subframes. The rare positioning of pilot symbols is used so that valid estimate of complicated gains can be achieved. The end squares estimates of the channel frequency process at the pilot symbols are calculated. The end squares[3] estimates are previously averaged to cut any unwanted noise from the pilot symbols. Virtual pilot symbols are created to hold the interpolation process at the edge of the gain of the sub frame where no pilot symbols may be located.



A. Get pilot symbols

The first step in imperative the least squares estimate is to gain the pilot symbols from their known location within the correct subframe. The price of these pilot symbols is known and herewith the channel receive at these locations can be determined by via the least squares estimate which is obtained by dividing the absolute pilot symbols by their proposed value

$$(K) = (K)\ (K) + noise \qquad (1)$$

$$\mathrm{H}_{P,}(K) = \frac{\mathrm{YP(K)}}{\mathrm{XP(K)}} + noise \qquad (2)$$

Where Y(K) is approved symbol value, X(K) is transmitted symbol figure, H(K) is complexWhere Y(K) is approved symbol value, X(K) is transmitted symbol figure, H(K) is complex channel gain, HP, LS (K) is least squares estimate of pilot symbol locations, YP (K) is received symbol rate, XP (K) is known transmitted pilot symbol..

B. Noise

Noise is the smart parameter which is challenging hardship to raise estimation of channel accuracy. The least-squares estimates and the averaged estimates control the same data, apart from additive noise. Simply taking the difference between the two estimates will show in a figure for the noise level on the least squares channel estimates at pilot symbol locations

C. Pilot average

To cut back the effects of noise on pilot estimates, the averaging is done. This method actually reduces the levels of noise on pilot symbols which will further assist in minimizing leakage.

D. Interpolation

Once the noise has been drooping or removed from the least squares pilot symbol averages and heavy virtual pilots have been resourceful, it is free to manage interpolation to add the missing values from the channel approximation missing values from the channel estimation.

III. RECENT TRENDS

In 2015, B.Padma Sirisha, Dr. I.Santi Prabha presented an analytical approach for channel estimation in OFDM system based on Kalman filtering, in this approach, Kalman and Wiener filtering is used for Multiple- Input-Multiple-Output Orthogonal Frequency Division Multiplexing channel estimation. The channel Estimation is done using Least Square (LS) estimation. The Kalman and Wiener filtering estimation is based on estimation and prediction values. The proposed estimator outperforms the existing estimators in terms of Mean Square Error (MSE) and Signal to Noise Ratio (SNR). Finally, the performance is analyzed with the help of simulation results.[12]In 2014, Amit kapoor and Ishan Khurana presented Channel estimation based on Kalman filtering with BER reduction in MIMO-OFDM systems in which they showed efficient communication with multi- carrier modulation. MIMO technology uses spatial diversity technique by using multiple antennas at the transmitter and the receiver side. In MIMO frameworks, the information streams landing from various way with various time are consolidated at the recipient side. OFDM is a modulation scheme that enables advanced information to be productively and dependably transmitted over a radio direct even in multipath conditions. The fundamental thought of OFDM framework is to adjust the info information imageonto a gathering of subcarriers with predefined coefficients to such an extent that the created ICI inside the gathering will drop each other. The significant inconvenience of this approach is bit error rates. The channel estimation likewise assumes a critical part in MIMO-OFDM frameworks. There are number of channel estimation strategies which have as of now been proposed for MIMO-OFDM frameworks. In the previous years numerous strategies had been proposed to reduce bit error rates. in MIMO-OFDM frameworks. In this paper, we are proposing the new procedure to reduce bit error rate in MIMO-OFDM innovation. The proposed method is separating procedure under this system we utilize KALMAN channel for diminishing piece mistake rate. Utilizing Kalman channel, channel estimation is likewise done legitimately as contrasted and the genuine value.[13]

IV. PROPOSED METHOD

For more accurate channel estimation with low complexity, the proposed estimator first performs the TD index set estimation from the G× 1 CIR estimate hˆ = 1/P(FP,G) H and then the TD post-processing with the leakage nulling matrix P to suppress the leakage

(i) Threshold setting and TD index set estimation

Let L=$(F_{P,G}{}^{H})F_{P,G} - PI_G$ be the G×G leakage matrix

$$\text{with} \qquad [L]_{m,n} \triangleq \exp\left(-\frac{j\pi(m-n)}{NP/U}\right)\frac{\sin\left(\frac{\pi U(m-n)}{N}\right)/N}{\sin\left(\frac{\pi U(m-n)}{N}\right)/NP}.$$

Then, with virtual subcarriers (i.e., V 0 and N U), the G× 1 CIR estimate is obtained as

$$\hat{h} = \frac{1}{P}P\left(F_{F,G}\right)^{H}QF_{P,N}y = h + l + w \quad (5)$$

Where l = denotes the G× 1 leakage vector with G× G covariance matrix Rll E{ll^{H}} = ‾LRL^{H}.

However, the accuracy of the MST selection with virtual subcarriers is severely degraded due to the distortion caused by the leakage. Also, the leakage remains in the selected MST so that an error floor occurs unless a proper processing for the leakage is performed. To overcome the above problems, the proposed MST selection scheme is composed of the two steps as in Fig. 1: an initial index set estimation with the initial threshold γi to reduce the number of candidates (|ΩC||ΩG|) followed by a recursive MST selection with a successive leakage cancellation to determine the TD index set ΩT..

1. Initialization step : Ω
2. First step (candidate index set estimation): Ω
3. Second step (recursion): while
4: k← $arg\ \mathbf{max}_{n\epsilon\Omega_C}|\hat{\boldsymbol{h}}(n)|$
5: If $|\hat{\boldsymbol{h}}(k)| > \gamma_r, \Omega_C \leftarrow \Omega_C\{k\}, \Omega_T \leftarrow \Omega_T \cup \{k\}$, and
$\hat{\boldsymbol{h}}(j) \leftarrow \hat{\boldsymbol{h}}(j) - \frac{1}{P}\hat{\boldsymbol{h}}(k)[L]_{j,k} for\ j\epsilon\Omega_C\{k\}$
6. else break
7. end while

Similarly as shown under these assumptions, the initial threshold is obtained asSimilarly as shown in [11] under these assumptions, the initial threshold is obtained as

$$\boldsymbol{\gamma}_i = \sqrt{\frac{1}{L}\left(\frac{1}{L} + \frac{1}{P^2G^2}tr(LL^H) + \frac{1}{\rho P}\right)ln\left(\frac{1}{1-P_{MD}}\right)}$$

In step 2, a successive MST selection and leakage cancellation is done with the recursive threshold γr.

By assuming that the leakage is sufficiently suppressed, the recursive threshold in [8] can be directly used to minimize the MSE as

$$\boldsymbol{\gamma}_r = \sqrt{\frac{\ln((G-L)\rho P/L^2)}{\rho P - L}} \qquad (7)$$

(ii) Time-domain post-processing

The regularization-based TD post processing matrix for a given constant SNR ρ¯ is generated from the TD index set ΩT obtained as

V. SIMULATION RESULTS

Here prepared a chart for Kalman Filtering and Weiner filteringvalues for showing how the SNR is increasing and BER forboth filtering values are in decreasing manner.

SNR Value	Kalman Filtering	Weiner Filtering
5	0.00545501708984375	0.00689764022827148
10	0.00127823352813721	0.00166409015655518
15	0.000549411773681641	0.000723891788058811
20	0.000308072566986084	0.000417107343673706
25	0.000197090148925781	0.000271305084228516

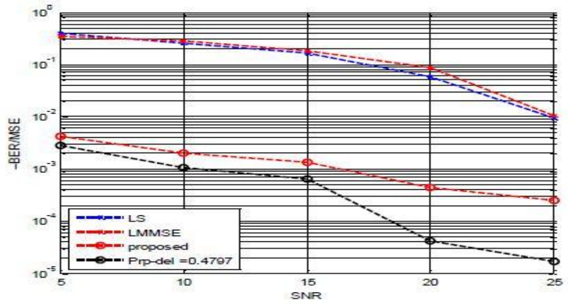


Figure 2: MSE performance versus SNR ρ

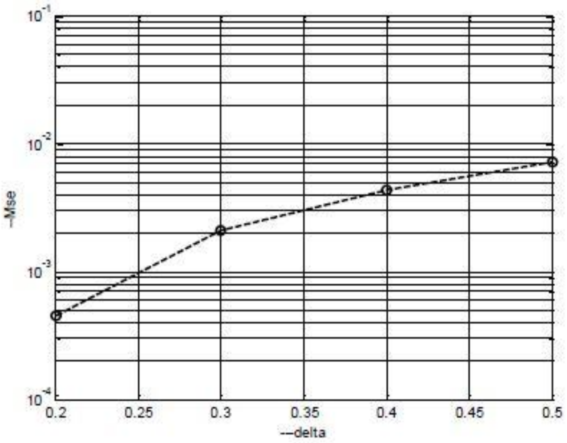


Figure 3: Performance of proposed method in terms of Delta vs MSE

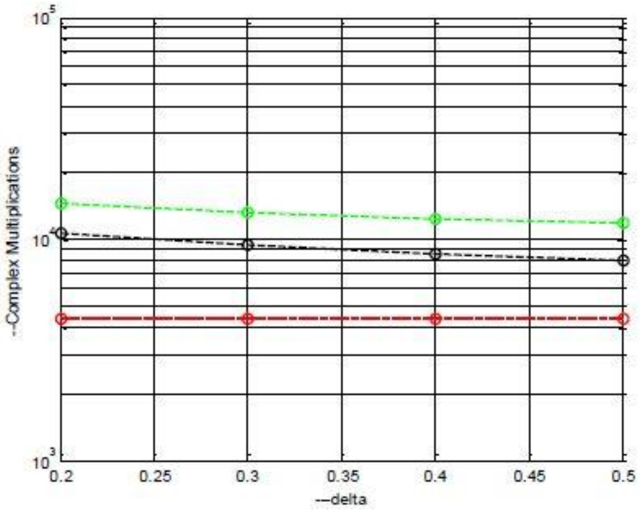


Figure 4: Performance of proposed method in terms of Delta vs Complex multiplications

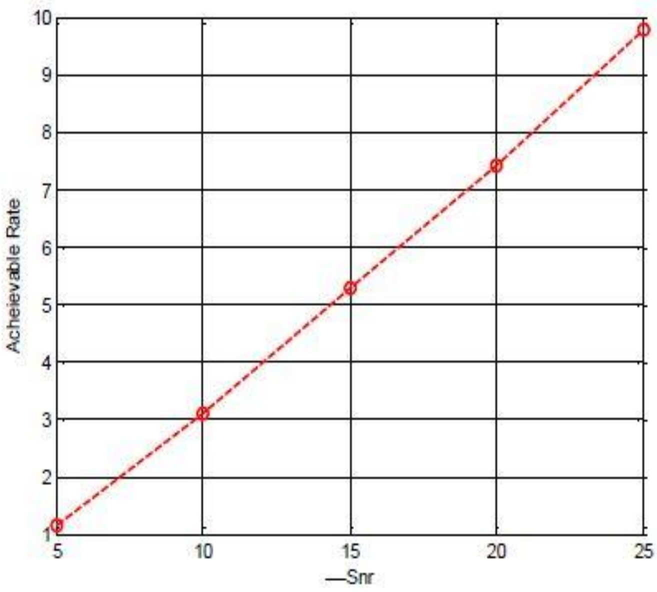


Figure 5: SNR achievable rate

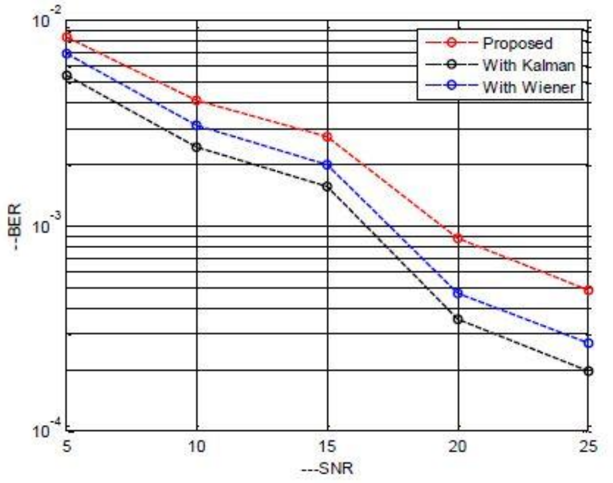


Figure 6: Performance analysis using Kalman and wiener filtering

VI. CONCLUSION

A low-complexity DFT-based channel estimator with leakage nulling for OFDM systems using virtual subcarriers. This estimator first estimates the MST set by considering the leakage effect and then performs a low-complexity leakage suppression by a regularized TD post-processing. From the results, it is absolute that the expected estimator boot provide near-optimal performance both in the point of the MSE and the achievable rate while keeping soft complexity similar to the simplest DFT-based channel estimator. But the confirm is not fully displayed so that we used Kalman and Wiener filtering that has to a great extent improved the performance of MSE with respect to SNR.

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