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A Review on Channel Estimator With Leakage Nulling

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Abstract: Although tremendous progress has been made on the past years on channel estimation in of dm 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-based channel estimator with leakage nulling is proposed for OFDM systems using virtual subcarriers. The flow of the proposed approach is initially starts with time-domain (TD) index set estimation considering the leakage effect then followed by low-complexity TD post-processing to suppress the leakage. The proposed channel estimator approach outperforms the existing channel estimators in terms of efficiency and performance. Finally the performance and complexity of the proposed algorithm are analysed by simulation results.

Keywords: OFDM, Channel estimation, Time domain, Wireless communications.

I. INTRODUCTION

Wireless communications are broadly classified into three different categories namely i) Conventional communication systems such as FDMA, TDMA which mainly has two drawbacks one is low data rate and low spectral efficiency. ii) Existing communication systems like CDMA are suitable for mobile and radar communication but the main drawback is drawback is data rate (speed). iii) Future generation communication models such as OFDM are used in Applications like 3G, 4G, LTE, WIFI, and WIMAX.

Orthogonal frequency division multiplexing is considered as highly successful communication model compares to conventional communication models because of low sensitivity to multipath propagation and eminent spectral efficiency. Orthogonal frequency division multiplexing too suffers from some drawbacks, high peak to average power ratio is main drawback which occurs due to the insufficiency power distribution by high power amplifier which results in in-band and out-band distortion. Digital communication are comprised of two communication representations pass band representation and base band representation, pass band represents continuous mode of communication while base band represents digital mode of communication. In our proposed work we present the base band representation of orthogonal frequency division multiplexing signal with N sub carriers as follows

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

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……….X_{N-1} $]^T$

T=Nt_s =symbol duration.

When the number of sub carriers is large then 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 order to resolve this issue several theories are proposed in the literature. One of such theory proposed in the literature is µ-law Companding; it reduces the Peak to average power ratio impact on orthogonal frequency division multiplexing in small amount. To overcome the drawback of µ-law Companding in our proposed work we present the Non linear Companding transform technique for efficient results.

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.

Orthogonal Frequency Division Multiplexing (Ofdm) System

Orthogonal frequency division multiplexing (OFDM) communication system has number of advantages over conventional communication techniques namely FDMA, TDMA and CDMA. Orthogonal frequency division multiplexing (OFDM) communication system has better spectral efficiency, high data rate, low inter carrier interference and moreover it is termed as future generation communication system because of its flexible and reliable high speed data rates, high spectral efficiency, high quality service and robustness against narrow band interference and frequency selective Fading.

Orthogonal frequency division multiplexing (OFDM) communication technique is recognized in the communications area for its high speed communications. The Orthogonal frequency division multiplexing (OFDM) communication technique has many advantages compares to the conventional communication techniques as follows
(i) High spectral efficiency
(ii) Immunity to the effects of fading

II. VARIOUS TECHNIQUE USED

OFDM techniques are quickly becoming a popular method for advanced communications networks. But, as there is growth of any communication there might be lacking, so to overcome this problem many existing methods which were used are as follows:

1) Leakage Nulling Channel Estimation for OFDM Systems Based on DWT and Low-Complexity Pilot-Aided Channel Estimation For OFDM Systems over Doubly-Selective Channels.
2) Analytical Channel Estimation Approach For OFDM System Based On Near- Optimal DFT-Based Channel Estimator With Leakage Nulling and Improving Channel Estimation in OFDM System Using Time Domain Channel Estimation for Time Correlated Rayleigh Fading Channel Mode.
3) Study of Synchronization Technique in OFDM System and OFDM Synchronisation Scheme to be used on a non frequency selective satellite channel.
4) The Effect upon Channel Capacity in Wireless Communications of Perfect and Imperfect Knowledge of the Channel and Improved Capacity Lower Bounds for Fading Channels with Imperfect CSI Using Rate Splitting.

The estimator consists of a time- domain (TD) index set estimation on the grounds that the leakage outcome followed through a low-complexity TD submit- processing to suppress the leakage. The performance and complexity of the proposed channel estimator are analyzed and established through computer simulation. Simulation outcome exhibit that the proposed estimator outperforms traditional estimators and provides near-most beneficial efficiency even as preserving the low complexity similar to the easy DWT-head quartered channel estimator.[3]

Tao Cui, Chintha Tellambura and Yue Wu we investigated channel estimation (CE) and data detection for OFDM systems over doubly- selective channels. We derive an oversampling basis expansion model (BEM) for doubly-selective channels and its statistical properties. The time diversity in the Doppler-induced inter- carrier-interference (ICI) and its relationship to the carrier frequency offset (CFO) induced ICI are illustrated using the BEM. We derive two low complexity linear minimum mean- square error (LMMSE) channel estimators using the BEM. The sphere decoder (SD) is modified to equalize the ICI channel. A low-complexity iterative equalizer without matrix inversion is also proposed. Our proposed channel estimators have low complexity and achieve good performance. Furthermore, the low-complexity iterative equalizer performs close to SD.[4]

M. Gowtham Reddy, D. Vijayakumar Reddy A novel channel estimation technique with virtual sub carriers is proposed in this work namely a low- complexity but near-optimal DFT- based channel estimator with leakage nulling is proposed for OFDM systems using virtual subcarriers. The flow of the proposed approach is initially starts with time domain (TD) index set estimation considering the leakage effect then followed by low - complexity TD post - processing to suppress the leakage. The proposed channel estimator approach outperforms the existing channel estimators in terms of efficiency and performance. Finally the performance and complexity of the proposed algorithm are analysed by simulation results.[5]

In 4G and beyond systems, to achieve higher capacity with better performance, Orthogonal Frequency Division Multiplexing (OFDM) is utilized. OFDM removes the deterioration in the channel due to multipath fading. It converts the frequency selective fading channel into flat fading channel. In this paper, improvement in channel estimation of OFDM system is shown in terms of Bit Error Rate (BER), Symbol Error Rate (SER) and Mean Square Error (MSE). This paper also includes the effect of changing number of subcarriers on the channel estimation performance. Improvement is shown between Least Square Error (LSE) estimation, Minimum Mean Square Error (MMSE) estimation and time domain channel estimation techniques i.e. Discrete Fourier Transform (DFT) and Discrete Cosine Transform (DCT) based channel estimation techniques on time correlated Rayleigh fading channel model i.e. Dent channel model using the 16-QAM modulation technique. Time domain channel estimation techniques are showing better performance with minimum complexity than Least Square Error (LSE) estimation and Minimum Mean Square Error (MMSE) estimation.[6]

An OFDM frequency synchronization scheme. This paper presents an extended solution for the carrier frequency synchronization problem of OFDM. The scheme uses number of bits, modulation level, cyclic prefix, FFT size similarly to the algorithm proposed by Tilde Fusco. The proposed scheme attains considerably higher accuracy than the scheme by requiring convolutional encoding data and viterbi decoding technique. Pilot Insertion and Cyclic Extension also included in the synchronization scheme. Our proposed method gives better results for different values of signal to noise ratio. [7]

An OFDM receiver for the forward link of a fixed broadband satellite system. We focus on the synchronization tasks in the receiver. Our objective is to reduce to the minimum the needed overhead, in order to improve spectral efficiency compared to a single carrier waveform system. A non pilot aided algorithm is used. However it is preceded by a coarse synchronization stage, in which a limited overhead is necessary (short cyclic prefix associated to a few number of pilots).[8]

Muriel Médard presented a model for time-varying communication single-access and multiple-access channels without feedback. We consider the difference between mutual information when the receiver knows the channel perfectly and mutual information when the receiver only has an estimate of the channel. We relate the variance of the channel measurement error at the receiver to upper and lower bounds for this difference in mutual information. We illustrate the use of our bounds on a channel modeled by a Gauss–Markov process, measured by a pilot tone. We relate the rate of time variation of the channel to the loss in mutual information due to imperfect knowledge of the measured channel.[9]

As shown by Medard ("The effect upon channel capacity in wireless communications of perfect and imperfect knowledge of the channel," IEEETrans. Inform. Theory, May 2000), the capacity of fading channels with imperfect channel-state information (CSI) can be lower-bounded by assuming a Gaussian channel input X, and by upper bounding the conditional entropy h(X|Y,ˆH), conditioned on the channel output Y and the CSI ˆ H , by the entropy of a Gaussian random variable with variance equal to the linear minimum mean-square error in estimating X from (Y,ˆH). We demonstrate that, by using a rate-splitting approach, this lower bound can be sharpened: we show that by expressing the Gaussian input X as as the sum of two independent Gaussian variables X (1) and X (2), and by applying Medard's lower bound first to analyze the mutual information between X(1) and Y conditioned on ˆH while treating X (2) as noise, and by applying the lower bound then to analyze the mutual information between X(2) and Y conditioned on (X(1),ˆH), we obtain a lower bound on the capacity that is larger than M´edard's lower bound.[10]

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 (MIMO-OFDM) 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.[11]

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 systems, the data streams arriving from different path with different time are combined at the receiver side. OFDM is a modulation scheme that allows digital data to be efficiently and reliably transmitted over a radio channel even in multipath environments. The main idea of OFDM system is to modulate the input data symbol onto a group of subcarriers with predefined coefficients such that the generated ICI within the group will cancel each other. The major disadvantage of this approach is higher bit error rates. The channel estimation also plays an important role in MIMO-OFDM systems. There are number of channel estimation methods which have already been proposed for MIMO-OFDM systems. In the past years many techniques had been proposed to reduce bit error rate in MIMO-OFDM systems. In this paper, we are proposing the new technique to reduce bit error rate in MIMO-OFDM technology. The proposed technique is filtering technique under this technique we use KALMAN filter for reducing bit error rate. Using kalman filter, channel estimation is also done properly as compared with the true value.[12]

IV. 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 using a regularized TD post-processing. From the results, it is confirmed that the proposed estimator can provide near-optimal performance both in the sense of the MSE and the achievable rate while keeping low complexity similar to the simplest DFT-based channel estimator. But the result is not properly displayed so here we used Kalman and Wiener filtering that has greatly improved the performance of MSE with respect to SNR.

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