AN EFFICIENT LOW COMPLEXITY MMSE FOR OFDM SYSTEMS

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ABSTRACT

OFDM is becoming the technique of choice for many high data rate wireless applications. OFDM systems are multi carrier systems in which the carriers are spaced as closely as possible while maintaining orthogonality, thereby efficiently using available spectrum. This technique is very use full in frequency selective channels, since it allows a single high rate data stream to be converted in to a group of many low rate data stream, each of which can be transmitted without inter symbol interference. Researchers are working at a greater extent on wireless applications. As per the literature many channel estimation technique have been proposed by the researchers.

The present work aims at the performance of channel estimation methods are investigated by MATLAB simulation. A novel MMSE channel estimation scheme is proposed and its performance is numerically confirmed for the OFDM system proposed in the IEEE 802.16 standards.

Keywords: *OFDM, channel estimation, frequency-selective fading channel.*

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INTRODUCTION

OFDM technology is a popular technique for transmission of signals over wireless channels, due to its many advantages such as the high spectral efficiency, robustness to frequency selective fading, and the feasibility of low-cost transceiver implementations [6]. For wideband wireless communication, it is necessary to dynamically estimate the channel before demodulating the signals. There are two kind methods for channel estimation. The first is the pilot assisted estimation, the pilot signals are embedded in certain sub-carriers of each OFDM symbol [4].

At the receiver, the channel components estimated using these pilots are interpolated for estimating the complete channel. Based on the criterion of realization, it can be classified as Least Square (LS), MMSE, and maximum likelihood estimator and so on [1].The second category is the

Blind channel estimation. The blind schemes avoid the use of pilots, for achieving high spectral sufficiency. This is achieved at the cost of higher implementation complexity and some amount of performance loss [5].Now propose a low complexity MMSE estimation scheme which can reduce computational complexity but cause little attenuation of performance.

LITURATURE SURVEY

1. A new derivation of least-squares-fitting principle for OFDM channel estimation.

Many channel estimation and data detection algorithms of the orthogonal frequency division multiplexing (OFDM) system have been proposed. Some of these algorithms are based on the principle of linear minimum mean-square error (LMMSE) estimation, which is theoretically optimal. There are also some algorithms developed based on the least-squares-fitting (LSF) principle, which finds a regression polynomial to it a block of tentative channel estimates in the least-squares sense. The LSF principle is a non-statistical approach, while the LMMSE algorithm is statistical and it needs to known or estimate the channel statistics like correlation matrices and signal-to-noise ratio (SNR). This letter proposes a novel viewpoint of the LSF principle. We show that the non-statistical LSF principle can be derived alternatively from the statistical LMMSE principle by eigenvector approximation. This constructs a link between these two principles. The mean-square estimation error (MSEE) analysis shows that there are common terms in the MSEE expressions of these two principles. This further validates the

constructed link. Based on the derived link and MSEE analysis, we also give some characteristics and discussions of the LSF principle.

2. Robust channel estimation for OFDM systems with rapid dispersive fading channels.

Orthogonal frequency division multiplexing (OFDM) modulation is a promising technique for achieving the high-bit-rates required for a wireless multimedia service. Without channel estimation and tracking

OFDM systems have to use differential phase-shift keying (DPSK), which has a 3 dB signal-to-noise ratio (SNR) loss compared with coherent phase-shift keying (PSK). To improve the performance of OFDM systems by using coherent PSK, we investigate robust channel estimation for OFDM systems. We derive a minimum mean-square-error (MSE) channel estimator, which makes full use of the time- and frequency-domain correlations of the frequency response of time-varying dispersive fading channels. Since the channel statistics are usually unknown, we also analyze the mismatch of the estimator to channel statistics and propose a robust channel estimator that is insensitive to the channel statistics. The robust channel estimator can significantly improve the performance of OFDM systems in a rapid dispersive fading channel.

3. Low complexity channel estimation for space-time coded wideband OFDM systems.

In this article, channel estimation for space-time coded orthogonal-frequency division multiplexing (OFDM) systems is considered. By assuming that the channel frequency response is quasi-static over two consecutive OFDM symbols, we develop channel parameter estimators based on the use of space-time block coded (STBC) training blocks. Using an STBC training pattern, a low-rank Wiener filter-based channel estimator with a significant complexity reduction is proposed. A simplified approach for the optimal low-rank estimator is also proposed to further reduce the estimator complexity while retaining accurate frequency domain channel estimation. Numerical results are provided to demonstrate the performance of the proposed low complexity channel estimators for space-time trellis coded OFDM systems.

4. Blind adaptive channel estimation in OFDM systems.

Consider the problem of blind channel estimation in zero padding OFDM systems and propose blind adaptive algorithms in order to identify the impulse response of the multipath channel. In particular, we develop RLS and LMS schemes that exhibit rapid convergence combined with low computational complexity and numerical stability. Both versions are obtained by properly modifying the orthogonal iteration method used in numerical analysis for the computation of singular vectors. With a number of

simulation experiments we demonstrate the satisfactory performance of our adaptive schemes under diverse signaling conditions.

In July 1998 O. Edfors, M. Sandell, and J.-J. van de Beek,published "OFDM channel estimation by singular value decomposition," In this paper we present and analyse low rank channel estimators for OFDM systems using the frequency correlation of the channel. Low rank approximation based on the discrete Fourier transform (DCT) have been proposed, but these suffer from poor performance when the channel is not sample spaced. We apply the theory of optimal rank reduction to linear minimum mean squared error(LMMSE) estimators and show that these estimators are robust.

In July 1998 Y. Li, L. J. Cimini, Jr., and N. R. Sollenberger did work on "Robust channel Estimation for OFDM systems with rapid dispersive fading channels," In this paper they proposed robust channel estimation approach to estimate the channel fading in time domain. The estimation criterion is to minimize the worst possible amplification of the estimation errors in terms of the exogenous input disturbances such as multiplicative and additive noise. The criterion is different from the traditional minimum estimation error variance criterion for the Kalman estimation algorithm, and requires no a priori knowledge of the disturbance statistics.

In Dec. 2001 M. Morelli and U. Mengali, published paper on "A comparison of pilot-aided channel estimation methods for OFDM systems, In this paper, the channel estimation methods for OFDM systems based on comb-type pilot sub-carrier arrangement are investigated.

The channel estimation algorithm based on comb type pilots is divided into pilot signal estimation and channel interpolation. The pilot signal estimation based on LS or MMSE criteria, together with channel interpolation based on piecewise-linear interpolation or piecewise second-order polynomial interpolation is studied.

In Sep. 2003Y Gong and K. Ben Letaief, published paper on "Low complexity channel estimation for space-time coded wideband OFDM systems," The paper proposes a computationally efficient, pilot aided linear minimum mean-square-error (MMSE) time-domain channel estimation algorithm for OFDM systems with transmitter diversity in unknown wireless fading channels. The proposed approach employs a convenient representation of the channelimpulse responses based on the Karhunen-Loeve (KL) orthogonal expansion and finds MMSE estimates of the uncorrelated KL series expansion coefficients. Based on such an expansion, no matrix inversion is required in the proposed

MMSE estimator. Subsequently, optimal rank reduction is applied to obtain significant taps resulting in a smaller computational load on the proposed estimation algorithm.

In 2004 R. Prasad the author and proposed a paper called OFDM for Wireless Communications Systems. In his paper has explained how OFDM technique in wireless communication systems. He proposed the block diagram for OFDM system.

In July 2006 X. G. Doukopoulos and G. V. Moustakides, published paper on "Blind adaptive channel estimation in OFDM systems,"The problem of blind channel estimation in zero padding OFDM systems, and propose blind adaptive algorithms in order to identify the impulse response of the multipath channel. In particular, we develop RLS and LMS schemes that exhibit rapid convergence combined with low computational complexity and numerical stability. Both versions are obtained by properly modifying the orthogonal iteration method used in numerical analysis for the computation of singular vectors. With a number of simulation experiments we demonstrate the satisfactory performance of our adaptive schemes under diverse signaling conditions.

METHODOLOGY

The modulation & demodulation method of pilot symbols and data symbols is QPSK. In order to reduce the complexity of MMSE channel estimation proposed to use an algorithm called singular value decomposition (SVD), it will inevitably cause attenuation of performance. In order to reduce the complexity of MMSE channel estimation with little or no attenuation, we use new method called diagonal matrix.

INDENTATIONS AND EQUATIONS

There are two kind methods for channel estimation. The first is the pilot assisted estimation, the pilot signals are embedded in certain sub-carriers of each OFDM symbol. At the receiver, the channel components estimated using these pilots are interpolated for estimating the complete channel. Based on the criterion of realization, it can be classified as Least Square (LS), MMSE, and maximum likelihood estimator and so on. The second category is the blind channel estimation. The blind schemes avoid the use of pilots, for achieving high spectral sufficiency. This is achieved at the cost of higher implementation complexity and some amount of performance loss.

Propose a low complexity MMSE estimation scheme which can reduce computational complexity but cause little attenuation of performance. The final scheme shows to be efficient according to our extensive computer simulations.MSE and BER performance of channel estimation methods are investigated by MATLAB simulation. The MATLAB version used is

MATLAB 2011. The modulation & demodulation method of pilot symbols and data symbols is QPSK.

The simulation results demonstrate the effectiveness of the proposed scheme. The MSE of channel estimation is defined by

$$\mathbf{MSE} = \mathbf{1}/M \sum_{i=1}^{M} \mathbf{E}[\,|\hat{\mathbf{H}}_i(\mathbf{k}) - \mathbf{H}_i(\mathbf{k})|^2$$

The computational complexity reduction ratio (CCRR) of the proposed MMSE over the conventional scheme is defined as

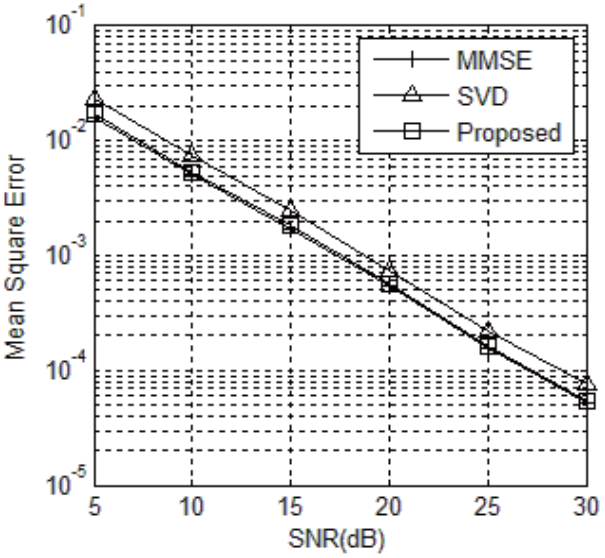
$$CCRR = 1 - \left(\frac{Complexity\ of\ the\ proposed\ scheme}{Complexity\ of\ the\ original\ scheme}\right) \times 100(\%)$$

The results will show that as compared with conventional MMSE, using this scheme can reduce the computational burden.

SIGNIFICANCE OF THE STUDY

Since this scheme can reduce the computational burden and suffer little attenuation of performances. Therefore, it is rather attractive for practical application in OFDM-based communication systems. **O**FDM technology is a popular technique for transmission of signals over wireless channels, due to its many advantages such as the high spectral efficiency robustness to frequency selective fading, and the feasibility of low-cost transceiver implementation.

FIGURES AND TABLES



MSE vs. SNR of three channel estimation methods

Computational complexity of the proposed mmse and the Conventional scheme when *N*=128

	Conventional	Proposed	CCRR
multiplications	81,920	33,408	59.21%
additions	16,384	128	99.22%

CONCLUSION

In this paper, a novel MMSE channel estimation scheme is proposed and its performance is numerically confirmed for the OFDM system proposed in the IEEE 802.16 standard. The results show that as compared with conventional MMSE, using this scheme can reduce the computational burden and suffer little attenuation of performances. Therefore, it is rather attractive for practical application in OFDM-based communication systems.

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