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One-Shot Blind CFO and Channel Estimation for OFDM With Multi-Antenna Receiver

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Abstract :- In this paper we design a new blind joint carrier frequency offset(CFO) and channel estimation with multi-antenna receiver. In this algorithm we will use only one received OFDM block therefore it falls under the category of one-shot estimation methods. The advantages of this proposed algorithm are 1) it supports fully loaded data carriers 2) the channel from transmitter to each receiver antenna can be blindly estimated 3) the algorithm based on this lines will replace the existing methods. Moreover, we also derive the Cramer-Rao Bounds (CRB) of this method. Also we are using ultra wide band between transmitter and receiver to increase efficiency by consuming less power. Numerical results show the effectiveness of the proposed algorithm.

Keywords: - Blind algorithm, carrier frequency offset (CFO), channel estimation, multi-antenna, one-shot estimation, orthogonal frequency division multiplexing (OFDM), ultra white band.

I. INTRODUCTION

ORTHOGONAL frequency division multiplexing (OFDM) has drawn substantial research interests during the past decade and has been deemed as the key component of future wireless communication systems. Although OFDM is immune to frequency-selective fading, its performance is more sensitive to carrier frequency offset (CFO) that is caused by oscillator mismatch between the transceivers. If the CFO is not properly compensated, the so introduced inter-carrier interference (ICI) could significantly degrade the system performance. Intensive studies have been carried out on the CFO estimation for OFDM system. A typical way is to use the data aided approaches. For example, two training based CFO estimators are derived from the maximum likelihood (ML) criterion for OFDM systems with timing ambiguity. The work is further investigated CFO estimation when both timing offset and channel lengths are not exactly known. On the other side, blind estimation has also attracted large amount of attention due to its improved spectral efficiency.

For example, the CFO can be blindly obtained based on the kurtosis-type criterion, diagonally criteria oversampling constant modulus constellations or the presence of null subcarriers. Especially, the methods in are one-shot estimators which require only a single received OFDM block, which exhibit both the spectral efficiency and time efficiency. In addition, several blind CFO estimators benefiting from multi-antenna redundancy have also been proposed recently. For examples, considered multiple antennas at the receiver and designed a CFO estimation method based on the tri linear decomposition. An improved estimator based on the multi-invariance property was later proposed. Both the methods support fully loaded transmissions but require a relative large number of received OFDM blocks. More recently, proposed a blind ML CFO estimator for OFDM system when the receiver has multiple antennas. Moreover does not consider the channel length information, which is usually bounded by the length of cyclic prefix (CP) in practical OFDM systems. On the other side, few of above CFO estimation methods could obtain the channel estimate in the meantime. Though can further obtain the frequency domain channel responses after CFO estimation, it requires a number of pilot symbols to remove the channel estimation ambiguity.

Nevertheless, there are many blind channel estimation algorithms for OFDM without CFO estimation, for example, the subspace-based channel estimation method. However, most existing subspace-based methods require sufficient number of received blocks in order to build reliable sample covariance.

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II. SYSTEM DESIGN

Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used in applications such as digital television and audio broadcasting, DSL Internet access, wireless networks, power line networks, and 4G mobile communications. OFDM is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. A large number of closely spaced orthogonal sub-carrier signals are used to carry data on several parallel data streams or channels. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase-shift keying) at a low symbol rate, maintaining total data rates similar to conventional single carrier modulation schemes in the same bandwidth.

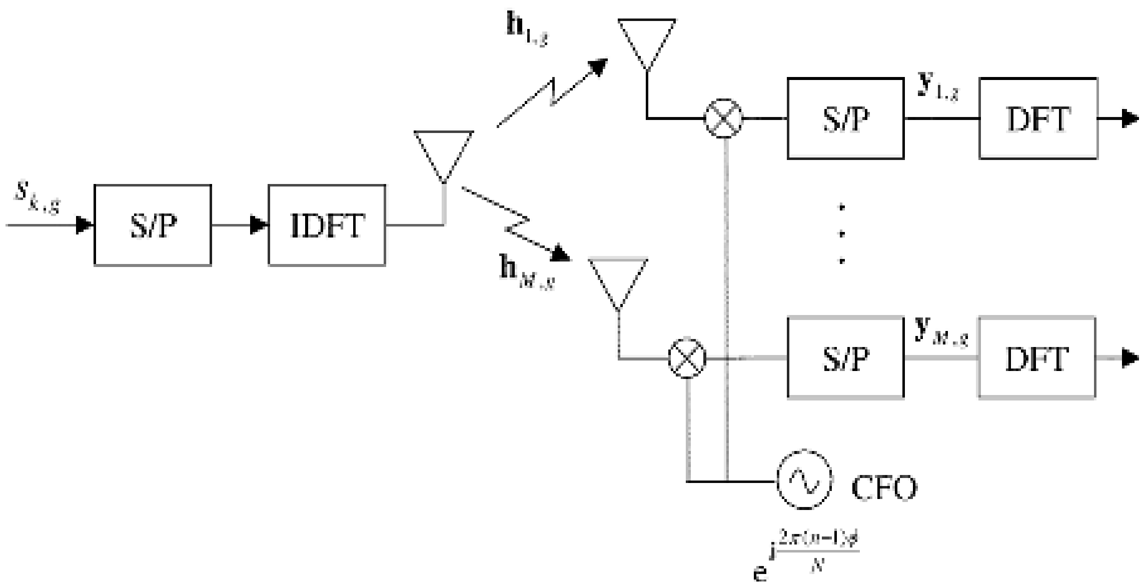

Fig.1. Illustration of OFDM system with multi-antenna receiver

The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions (for example, attenuation of high frequencies in a long copper wire, narrowband interference and frequency-selective fading due to multipath) without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly modulated narrowband signals rather than one rapidly modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to eliminate inter symbol interference (ISI) and utilize echoes and time-spreading (on analogue TV these are visible as ghosting and blurring, respectively) to achieve a diversity gain, i.e. a signal-to-noise ratio improvement.

This mechanism also facilitates the design of single frequency networks (SFNs), where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined constructively, rather than interfering as would typically occur in a traditional single-carrier system. In estimation theory and statistics, the **Cramér–Rao bound (CRB)** or **Cramér–Rao lower bound (CRLB)**, named in honor of Harald Cramér and Calyampud Radhakrishna Rao who were among the first to derive it, and expresses a lower bound on the variance of estimators of a deterministic parameter. The bound is also known as the **Cramér–Rao inequality** or the **information inequality**. In its simplest form, the bound states that the variance of any unbiased estimator is at least as high as the inverse of the Fisher information. An unbiased estimator which achieves this lower bound is said to be (fully) efficient. Such a solution achieves the lowest possible mean squared error among all unbiased methods, and is therefore the minimum variance unbiased (MVU) estimator. However, in some cases, no unbiased technique exists which achieves the bound. This may occur even when an MVU estimator exists.

III. CRAMER-RAO BOUND

In estimation theory and statistics, the **Cramer–Rao bound (CRB)** or **Cramer–Rao lower bound (CRLB)**, named in honor of Harald Cramer and Calyampud Radhakrishna Rao who were among the first to derive it, and expresses a lower bound on the variance of estimators of a deterministic parameter. The bound is also known as the **Cramer–Rao inequality** or the **information inequality**. In its simplest form, the bound states that the variance of any unbiased estimator is at least as high as the inverse of the Fisher information. An unbiased estimator which achieves this lower bound is said to be fully efficient. Such a solution achieves the lowest possible mean squared error among all unbiased methods, and is therefore the minimum variance unbiased (MVU) estimator. However, in some cases, no unbiased technique exists which achieves the bound. This may occur even when an MVU estimator exists

IV. CONCLUSION

In this paper, we designed a new joint blind CFO and channel estimation method for OFDM system with multi-antenna receiver. This method works when the system is fully loaded and is valid for only one OFDM block. Also the channel estimation between transmitter and receiver can be achieved. We also derive the CRB of this method, where the system attains the CRB in high SNR range. We adopt Ultra Wide Band in multi band OFDM such that error ratio is going to decrease.

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