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DCT-Based Channel Estimation in Multi-Antenna Interference Channels

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ABSTRACT:Channel state information (CSI) gathering is vital for interference minimization. Wireless networks often suffer from multi cell interference, which can be minimized by deploying beam forming to spatially direct the transmissions. The accuracy of the calculation of CSI plays an important role in designing accurate beam formers that can control the amount of interference created from synchronous spatial transmissions to mobile users. Therefore, a new technique which uses the spatial covariance matrix and the discrete cosine transform (DCT) is proposed to increase channel estimation in the existence of interference. Bayesian estimation and least squares estimation are introduced by using the DCT to separate the overlapping spatial paths that result in interference. The spatial domain is thus exploited to minimize the impurity in the signal which is able to discriminate across interfering users. It implemented using MATLAB.

KEYWORDS: Channel estimation, discrete cosine transform, training sequence contamination.

I.INTRODUCTION

Interference is most important factor for designing wireless networks. Interference leads to spectrum scarcity-congestion problems, so spectrum management to be carefully done. Spectrum Management is the process of distributing and regulating the use of radio frequencies to improve its usage. If Spectrum management not carried out in efficient way there will be shortage of frequency which leads to spectrum congestion problem. Previously Cellular networks were using partial frequency reuse nowadays they are shifted to full frequency reuse, thus we can use full spectrum and interference is avoided to some extent. Therefore future networks will require the installation of base station in such a way that these base stations can jointly serve their users and to smartly minimize the interference. To achieve this we have to exchange data information and channel state information [3]. But to do so we need backhaul exchange for users' data which cannot be achieved now because we need major upgrade to current infrastructure. In order to tackle the interference issue without data sharing over backhaul network, different coordination techniques has been proposed to handle limited data exchange. In thus technique CSI is available at BS which helps to design precoding techniques that minimize the interference created by BS transmissions by adjusting the signal to leakage noise ratio while in other techniques zero forcing beams forming in a coordinated multi cell environment is used. Implementing these techniques requires accurate channel state information todesign the useful transmit and receive beam forming.

The CSI gathering techniques are feedback and reciprocity techniques [3]. In the feedback systems, a training sequence is simultaneously sent in every direction by the BS which is measured by users and a limited feedback link is studied which is sent from the users to the base station. In the second mode, the different characteristics of such systems is the concept of reciprocity, where the uplink channel is used as an estimate of the downlink channel diminishing the feedback requirements. CSI is typically gathered by applying finite-length training sequences in the presence of inter-cell interference. Therefore, in a synchronous setting, the training sequences from neighboring cells would infect each other. While in an asynchronous setting, the training sequences are infected by the downlink data transmissions.

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II.BACKGROUND

Channel Estimation Techniques:

Channel Estimation is the process of defining the effect of the physical medium on the input data sequence. It is an important and vital function for wireless systems. Even with a quite knowledge of the wireless channel properties, a receiver can observe into the data sent over by the transmitter.The main aim of channel estimation is to measure the effects of the channel on known or partly known set of transmissions. Orthogonal Frequency division multiplexing (OFDM) system specially suited for channel estimation [1]. The sub carriers are closely spaced. While the system is mostly used in high speed applications that are efficient of computing channel estimates with minimum delay [3].

• Least Squares (LS)
• Minimum Mean Squares (MMSE)

Least Squares (LS):

The method of least squares is a basic approach to the close solution to systems where there are more equations than unknowns. This approach in [3] minimizes sum of squares of errors made in the every single equation.

This technique is widely used in data fitting. The best fit in the least-squares sense minimizes the sum of squared outcomes, a outcome being the difference between an observed value and the fitted value provided. When the problem hasmassive uncertainties in the independent variable [2], so the methodology required for fitting errors-in-variables models may be considered instead of that for least squares.

Least squares have two main problems: linear or ordinary least squares and non-linear least squares, depending on whether or not the outcomes are linear in all unknowns [3]. The linear least-squares problem occurs in statistical regression analysis, and it has a closed-form solution. A closed-form solution is any formula that can be calculated in a finite number of standard operations. The non-linear problem has no such solution and is usually solved by repetitive refinement; after every repetition the system is approximated by a linear one, and thus the core calculation is similar in both cases.

Minimum Mean Square Error (MMSE):

Minimum mean square error estimator is an estimation method which minimizes the mean square error (MSE) of the fitted values of a dependent variable, which is a measure of estimator quality.The term MMSE mainly indicates estimation in a Bayesian setting with quadratic cosinet function. The basic idea behind the Bayesian approach to estimation from practical situations where we often have some previous information about the parameter to be estimated. We may have previous information about range that the parameter can assume; or we may have an old estimate of the parameter that we want to improve when a new observation is made available.This is in contrast to the non-Bayesian approach where nothing is known about the parameter in advance and which does not explain such situations. In the Bayesian approach, such prior information is conqured by the prior probability density function of the parameters; and based directly on Bays theorem, it gives us better posterior estimates as more observations become available. Thus unlike non-Bayesian approach where parameters of interest are assumed to be deterministic, but unknown constants, the Bayesian estimator attempt to estimate a parameter that is itself a random variable.

Discrete Cosine Transform:

A finite sequence can be shown in terms of a sum of cosine functions oscillating at different frequencies [6]. DCTs are important to various applications in engineering, from lossy compression of audio and images to spectral techniques for solution of partial differential equations. The use of cosine function rather than sine functions is critical for compression, since it turns out fewer cosine functions are needed to get back a exact typical signal, whereas for differential equations the cosine function express a particular choice of boundary conditions.

DCT is as same as the discrete Fourier transform, but using only real numbers [6]. The DFT's operating on real data with even symmetry is same as DCT,where in some variants the input and/or output data are shifted by half a sample. Major contribution of DCT is in solving partial differential equations by spectral methods, where the different variants of the DCT are related to slightly different even/odd boundary conditions at the two ends of the array.

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III. PROPOSED WORK

The regular channel estimation techniques are combined with the Discrete cosine transform which will help in better channel estimation. By means of DCT the unimportant frequencies (where the signal strength is low) will be eliminated. The energy compaction property is used which is major advantage of DCT.

The contributions of this paper can be summarized as

• Improving the contamination minimization performance of the old-fashioned Bayesian estimation (BE) at the estimation step. BE is used to mitigate the contamination and analyse its performance using large system analysis [6]. In this work, we couple BE with DCT in different scenario's to clean up the training sequences at the estimation process. Moreover, a modification is employed on traditional BE to improve the contamination rejection from the target estimate. Numerically, the proposed algorithms are better in performance than the estimation algorithm proposed.

• Traditionally, least squares estimation (LS) Technique is not capable of separating the interference. We apply LS in the DCT [2] domain to minimize the contamination at the estimation process by using DCT characteristics.

• Training sequence allocation techniques are proposed to find the optimal set of users that utilize the same training sequences. In an effort to utilize the multiuser diversity

Concept, we propose combined training sequence allocation and DCT compression to combine the benefit of both schemes [6]. These allocation techniques further suit the nature of enhanced LS and BE there by outperforming the traditional techniques.

V. RESULT AND DISCUSSION

We investigated the performance of Bayesian estimation and a least square estimation framework and formulated the lower bound and the upper bound of mean square error for such estimator. In comparison with the regular channel estimation techniques the DCT based channel estimation gives better results; the channel estimation is compared in the form of mean square error. The ideal system must have the zero mean square error but in practical scenario this is not possible. In practical scenario the mean square error must be less as signal to noise ratio increases.

By using DCT the channel estimation got improved, the various scenario like channel estimation with regular technique LS and MMSE, channel estimation by using DFT, Channel estimation using DCT is compared. DCT gives better performance with respect to all.

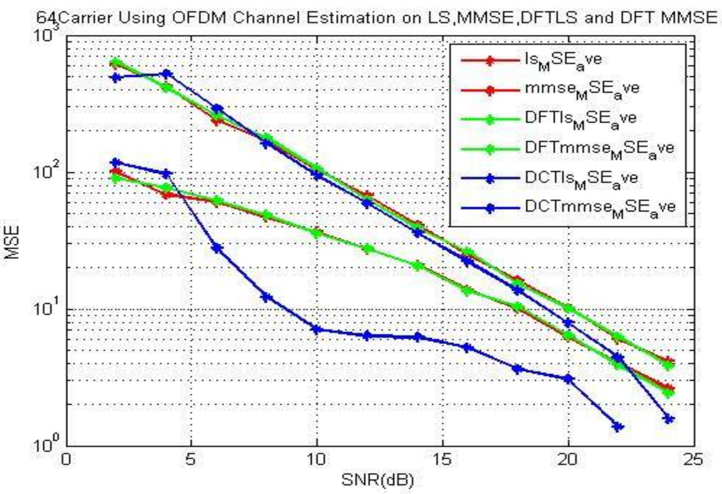

Fig. 1 Comparison between different channel estimation techniques

VI.CONCLUSION

We proposed modified techniques to enhance the estimation accuracy by introducing the DCT, thereby transforming the problem into a different domain. This allowed the development of a new interference mitigation algorithm by compressing the spatial frequencies. It improves estimation utilizing the DCT compressing ability to

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diminish the overlap in the interfering subspaces and boost the separation in the spatial domain. We incorporated this concept with training sequence allocation to assign different training sequences to reduce the interference in the overlapping area of the DCT subspaces. The performance of proposed algorithms was studied and compared to current state of the art techniques.

IV.FUTURE WORK

As Discrete Cosine Transform is used with the least square and Minimum Mean Square, the discrete wavelet transform is also can be used for channel estimation. In numerical analysis and functional analysis, a discrete wavelet transform (DWT) is for which the wavelets are discretely sampled [9]. As with other wavelet transforms, a main benefit it has over Fourier transforms is temporal resolution: it abducts both frequency and location information (location in time). For an input represented by a list of 2^n numbers, the Haar wavelet transform may be considered to couple up input values, storing the difference and passing the sum [9]. This process is repeated so many times, pairing up the sums to offer the next scale, which leads to 2^n-1 differences and a final sum. The Haar DWT explains the desirable properties of wavelets in general. First, it can be achieved in O(n) operations; second, it captures not only a notion of the frequency content of the input, by inspecting it at different scales, but also progressive content, i.e. the times at which these frequencies occur. Jointly, these two properties make the Fast wavelet transform (FWT) an optional to the conventional fast Fourier transform (FFT).

The discrete wavelet transform is widely used in many applications in engineering, and mathematics [9]. Most notably, it is used for signal coding, to represent a discrete signal in a redundant form, frequently as a preconditioning for data compression. Conventionally, Fourier transform has been used mostly to examine the spectral content of a signal. However, Fourier transform is not able to represent a non-stationary signal sufficiently; whereas time-frequency analysis function, e.g., Haar transform, is found in effect as it provides a simple approach for examining the local features of a signal. The Haar transform uses Haar function as its basis. The Haar function is an orthonormal, rectangular pair. Related to the Fourier transform basis function which only varies in frequency, the Haar function differs in both scale and position. The Haar transform is compact, dyadic and orthonormal. The Haar transform serves as a model for the wavelet transform, and is closely related to the discrete Haar wavelet transform. The Haar transform is used in signal compression mechanism [9]. There are two basic categories of compression techniques. The first category is the lossless compression. As the name stand, the de-compressed signal is error-free. Typical lossless methods are Huffman compression, LZW compression, arithmetic compression and run-length compression. The other type is the lossy compression. Even though this type of compression method produces error in the de-compressed signal, the error should only by marginal. The advantage of lossy techniques is that higher compression ratio can be achieved, when compared to the lossless compression technique. The Haar transform is a type of lossy compression.

A threshold of 0.3536 is chosen based on the cumulative energy distribution of the Haar transformed signal. Thereafter, compressed signal is obtained via inverse Haar transform, The maximum error calculated over all values of approximated signal is no more than 3.91 × 〖10〗^(-3)

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