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Sparse Channel Estimation in Mimo-Of Dm Communication

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Abstract: Wireless communication system is prone to distortions and noise. The system utilizes many techniques to minimize the distortions and noise effects. The use of channel estimators is one of the many techniques and has decent success. The channel estimation is important process in modern wireless communication as it provides the channel state information. Thus it is important to get correct channel state information so that we can have distortion less signal at the receiving end. Pilot based and blind channel estimators are used for this purpose but are not successful in providing high data rates and complexity tradeoff. In this paper we try to provide a channel estimation scheme based on sparse channel estimation and SL0 algorithm. In this paper the sparse channel estimation is shown for multiple input multiple output (MIMO) communication using orthogonal frequency division multiplexing (OFDM). MATLAB software is used for the coding purpose and the system is tested for different parameters like mean square error and bit error ratio.
Keywords: MIMO, OFDM, Sparse channel, wireless communication, Smooth L0 norm

I. INTRODUCTION

Communication is very important part of modern lives. It is therefore necessary to find ways to have distortion less and effective communication medium. OFDM is used in variety of communication system and is effective in giving high spectral efficiency and reduced inter-symbol interference. Multiple output multiple input (MIMO) system is also useful in significantly increasing the capacity of the system. This is due to diversity and parallel transmission of the information between transmitter antennas and receiver antennas. Combining these two techniques givesadvantage over other techniques and provides reliable high data rate transmission over wireless channels.

The data received at the receiver must be decoded in order to get the information and hence requires correct decoding method and also to compensate channel distortion. Thus a good channel estimator is necessary at the receiver to provide accurate and distortion free data. Channel estimation gives channel state information which is very essential in reducing impact of the wireless channel during transmission. We can eliminate the need of channel estimation by using quadrature phase shift keying modulation. But it gives 3 DB loss in signal to noise ratio. Thus to improve performance of OFDM system coherent demodulation is employed with accurate channel estimation techniques.

Channel estimation must be accurate and less complex. Different methods are used to achieve both accuracy and non-complexity but it is difficult to get both. This is because the fading channel of OFDM is considered as 2D signal i.e. both time and frequency. The cannel estimator for such 2D signal is complex for practical implementation.

There are many estimators proposed like pilot based or blind channel estimators. These estimators are based on least square (LS), minimum mean square error(MMSE), maximum likelihood estimators etc.

Many papers are available in the literature giving the sparse channel techniques for channel estimation. Channel estimation using parametric channel model and minimum description length (MDL) is proposed in [3] and also another approach based on most significant taps to decide the channel order in [4].

In this paper, channel estimator based on sparsity of the channel is proposed with SL0 algorithm. The sparsity in wireless channels is due to large delay spread with few non-zero support. This gives the channels sparse impulse response. It can be used for channel estimation.

II. CHANNEL ESTIMATION

The increased capacity of the system due to MIMO is based on assumption that channel between transmitter and receiver are accurately known. But in reality we need to estimate the channel. The channel estimation is also very necessary in OFDM system to receive correct data at the receiver end. In OFDM system channel estimation is achieved by sending the known data to all subcarriers. There are many channel estimation techniques which are based on pilot or blind channel estimation. The pilot based techniques use training symbols which are already known at transmitter as well as at the receiver and they also use convolution properties of surrounding data symbol. The blind techniques do not use training symbols and the channel estimation is done using deterministic or stochastic methods. There also semi blind techniques which make use of combination of training based methods and blind methods.

III. SPARSE CHANNEL ESTIMATION

If number of multipath cannel component is lesser than channel length than the channel is said to be a sparse channel. To estimate such sparse channel the channel model must be clearly defined. We then must have analysis of such channel which is important for next steps of channel estimation. After proper analysis is done, a measurement matrix must be constructed for the channel with the data from the analysis step. This measurement matrix should be a match to the channel model and must meet the communication demands. Last step is to recover the channel by using different channel estimation methods.

The main steps in the sparse channel estimation are measurement matrix generation and sparse channel recovery. We will discuss more on these two steps.

A. Measurement Matrix

The process of measurement matrix construction has many factors. The main factor is pilot types namely fixed pilots or random pilots. In fixed pilots have fix value and position. The arrangement of these pilots is very important in the sparse channel estimation. Random pilots do not have any specific arrangement. The sparse channel high resolution is second factor and it is essential for estimation. There is computational complexity in channel estimation which can be reduced by using smart measurement matrix.

B. Sparse Channel Recovery

There are two types of channel estimation, frequency domain channel estimation and time domain channel estimation. Frequency channel estimation has least error (LS) and minimum square error (MMSE) as the two major methods. The LS method is more popular as it is less complex and it is used with different other interpolation method for better results. While MMSE method is more complex and it requires the knowledge of channel statistics and noise variance.

The time domain channel estimation also has LS, DFT based and maximum likelihood as major channel estimation methods. These channel estimation methods are affected by maximum delay in sparse channel and thus based on assumption that number of pilots are less than cyclic prefix. They can also estimate for multipath channel but we require threshold technique to achieve better performance.

IV. Sl0 algorithm

SL0 algorithm is very useful in computing the sparsest solution of the underdetermined linear equation. It is very fast compared to the other algorithms like L1-magic. This algorithm works by directly minimizing the L0 norm which is different than other algorithms which try to replace L1 and L0 with different cost functions.

The main working of this algorithm is to smooth the L0 norm. This is done by approximation of the L0 norm of vector with a smooth function. Smooth function is given as

$F_{\&sigma}\ (s)$.

&sigma gives the approximation for the smooth function. If we choose large &sigma the function will be smooth but approximation for L0 norm will be worst. On the other hand for smaller &sigma approximation for L0 norm will be better but the function will be less smooth.

Thus aim here is to minimize the smooth function for very small values of &sigma. But as we make &sigma smaller the smooth function will be highly non-smooth and it will have lot of local minima. Hence we need to use graduated non-convexity approach. In this approach we start with very large &sigma and decrease it gradually to zero. The minimum value for smooth function is used as initial point and we will locate minimum for next iteration of&sigma by using steepest descent approach. As this new value for &sigma is decreased by very small value than previous &sigma, the minimum value of smooth function is not reduced by large margin and thus no local minima is created.

V. Results

The proposed method is implemented in the MATLAB software and the results are obtained as minimum square error (MSE) and bit error rate (BER). The results are shown in the following figures.

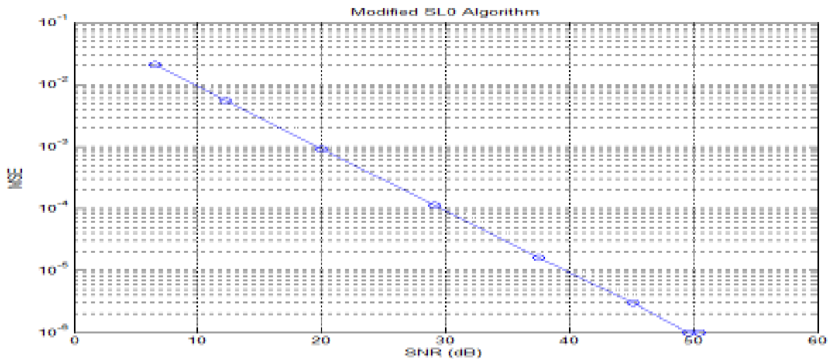

Fig.1: SL0 output in terms of MSE vs SNR

Here we can see that with high signal to noise ratio (SNR) values also we get very low mean square error (MSE) and the value goes on decreasing as the SNR value increases. Also in below graph the values for MSE are plotted for number of iterations and we can see that as number of iterations are increased the values of MSE are decreased. This shows that our system has given satisfactory result in terms of MSE and the results get better with duration.

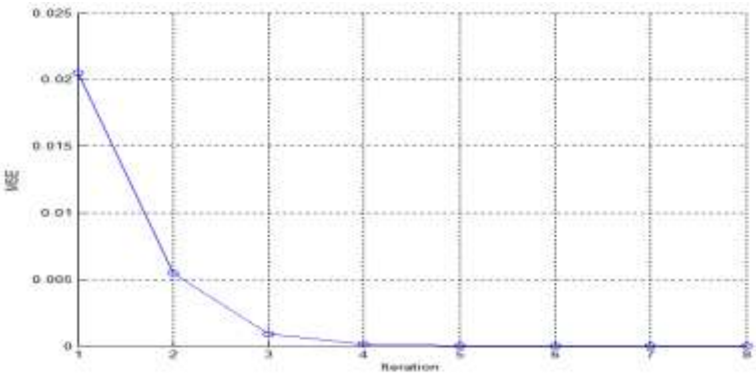

Fig.2:SL0 output in terms of MSE vs iterations

Also bit error ratio (BER) is plotted against the SNR values. The BER is decreased with increase in signal to noise ratio. Thus in terms of BER also this system performs well.

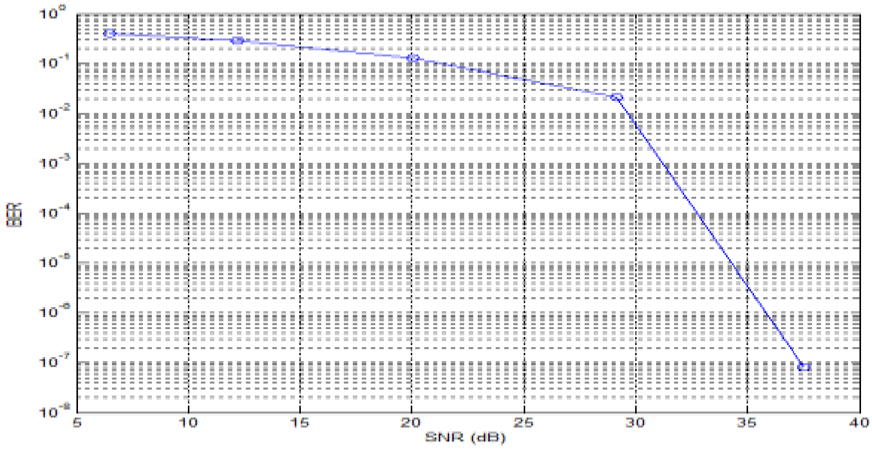

Fig.3: SL0 output in terms of BER vs SNR

VI. Conclusion

We successfully implemented sparse channel estimation scheme for MIMO-OFDM system with SL0 algorithm. The system was implemented in MATLAB software and results are shown in the previous section. The system works well in given scenarios of sparse nature of the channel and give mostly accurate results. The results are obtained with low BER and MSE with increased SNR, thus provide better implementation for real world scenario.

REFERENCES

[1]. RaisanuriHidayat, AnggunFitrianIsnawati, “Channel Estimation in MIMO-OFDM Spatial Multiplexing using least square method”, International Symposium on Intelligent Signal Processing and Communication System (ISPACS) December 2011

[2]. Hanks H. Zeng, “ Blind channel estimation using second order statistics”, August 1997

[3]. Yushi Shen and Ed Martinez: “Channel estimation in OFDM system” Rev.0, 1/2006

[4]. Mr. Abhishek Bhoyar: “A unified analysis of SINR for MIMO downlink system” Xenofon G. Doukopoulos and George V. Moustakides: “Blind adaptive Channel estimation in OFDM system”, February 2004

[5]. Kala Pravin Bagadi and Prof. Susmita das, “ MIMO-OFDM channel estimation using pilot carriers”, on (IJCA) International Journal of Computer Applications (0975 – 8887), Volume 2 – No.3, May 2010

[6]. Brian Carrol, “Analysis of Sparse Channel Estimation”, Thesis 2009

[7]. Hui Xie, “Sparse Channel Estimation inOFDM System”, South China University Of Technology, Guangzhou, Chine, 2014

[8]. MassoudBabaie-Zadeh, “Smoothed L0 (SL0) Algorithm for Sparse Decomposition”, 2010 Christian SchouOxvig, Patrick Steffen Pedersen, Thomas Arildsen, and Torben Larsen, “Improving Smoothed `0 Norm in Compressive Sensing Using Adaptive Parameter Selection”, arXiv:1210.4277v2 [cs.IT] 14 March 2013

[9]. Xinrong Ye, Wei-Ping Zhu, Aiqing Zhang and Jun Yan, “Sparse channel estimation of MIMO-OFDM systems with unconstrained smoothed l0-norm-regularized least squares compressed sensing”, EURASIP Journal on Wireless Communications and Networking 2013