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# Blind channel estimation for Multiple-Input Multiple-Output system using Constant Modulus Algorithm ☆

M. Kanmani [a,*], M. Kannan [b]

[a] Department of ECE, Jerusalem College of Engineering, Anna University, Chennai, Tamil Nadu, India
[b] Department of Electronics Engineering, Madras Institute of Technology, Anna University, Chromepet, Chennai, Tamil Nadu, India

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ABSTRACT

Multiple-Input Multiple-Output system plays a major role in the fourth generation wireless systems to provide high data rates. In this paper, a blind channel estimation approach has been proposed for finding the channel length based on the signals received from the MIMO (Multiple-Input Multiple-Output) transceiver. The resultant MIMO channel length information is utilized for estimation of the channel impulse response of the system. The estimation is used for adaptation of the equalizer weights, based on the proposed Constant Modulus Algorithm which has reduced the fading and multipath propagation resulting from Inter Symbol Interference. The performance of the proposed system has been analyzed in terms of Mean Square Error and Symbol Error Rate for various Signal to Noise Ratio.



## 1. Introduction

MIMO is one of the most promising techniques for achievement of high data rates and reliability over the broadband wireless medium [1,2]. The major issues in wireless medium data transfer are limited transmit power, scarcity of spectrum and the inability to support high quality video streaming, owing to the limited data rates achievable over wireless links. MIMO technology has received considerable attention in wireless communication, since it offers a significant increase in data throughput and link range without the need for additional bandwidth or transmit power. MIMO technique can significantly enhance channel capacity by utilizing the spatial diversity provided by multiple paths.

The rising demand of data rate in wireless applications, shadowing, multipath propagation and various fading have introduced Inter Symbol Interference (ISI) in addition to the channel Additive White Gaussian Noise (AWGN). The blind equalization technique has been followed to minimize the effect of ISI distortion. In this technique, one or more properties of the transmitted signal have been used for estimation of the inverse of the channel. Many equalizers such as blind equalizer using High Order Statistics (HOS) [3], equalizer based on Hidden Markov Models (HMM) [4], Minimum Mean-Square Error (MMSE) blind equalizer [5] and Turbo equalizer [6] have been introduced for enhancement of the system performance. The theoretical properties for blind equalizer such as the convergence of the blind equalization algorithm with respect to optimal condition and Signal-to-Interference Ratio (SIR) with respect to equalizer's length have been discussed in [7,8]. The heuristical experiments are generally used for determination of the equalizers lengths [9,10]. The general equalization scheme is not

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* Corresponding author.
*E-mail addresses:* kanmanirkt@gmail.com (M. Kanmani), mkannan@annauniv.edu (M. Kannan).

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optimal for accuracy and computational complexity. The Constant Modulus Algorithm (CMA) is well-established and frequently used blind equalization technique in many practical applications, since it does not require carrier synchronization [11–20]. The widely used CMA algorithms are Least Square CMA (LS-CMA) and Recursive Least Square CMA (RLS-CMA) for MIMO system. The LS-CMA can update the weight vector on a block by block basis, instead of each sample. When the block size is increased, the algorithm converges faster and the computational complexity increased due to the size increment in the estimated covariance matrix. The RLS-CMA requires more computations than the LS-CMA since the cost function is non-quadratic in the array weights. This algorithm provides greater convergence rate with the lagging ability to decrease the impact of interference contribution with equal modulus. A CMA approach has been utilized for suppression of the convergence error and for improvement of the equalization performance for multi-modulus symbols. In this approach, the channel length based on the statistics of the received signals from the MIMO transceiver has been used for the estimation of the Channel Impulse Response (CIR) which in turn updates the equalizer weights to minimize the cost function for a better Mean Square Error (MSE) and reduced Symbol Error Rate (SER).

This paper is organized as follows: The system model is introduced in Section 2 and then the blind channel estimation scheme is briefly discussed in Section 3. The simulation results are presented in Section 4 and the Conclusion is given in Section 5.

## 2. Mimo system model

The transmission model for MIMO transmission system is shown in Fig. 1. It consists of two transmit ($N_t = 2$) and two receive ($N_r = 2$) antennas assuming spatial multiplexing where OFDM (Orthogonal Frequency Division Multiplexing) data streams are transmitted across the two antennas. Each data stream consists of independent and identically distributed complex symbols which are modulated by subcarriers.

The proposed system consists of the transmitter and cyclic prefix to obtain MIMO OFDM signals. The transmitter is included with a data signal generator, an encoder using hamming codes, interleaver and QAM (Quadrature Amplitude Modulation) modulator. These signals are transmitted through the Rayleigh channel and added to Additive White Gaussian Noises. The received signal $r_j[k]$ at receiving antenna $j$ can be expressed as

$$r_j[k] = \sum_{i=0}^{N_t} \sum_{l=0}^{L_{ji}} h_{ji}[l] x_i[k-l] + \eta_j[k] \tag{1}$$

where $k = 1,2,\ldots,N$, $j = 1,2,\ldots,N_r$, $h_{ji}[l]$ is the impulse response for the propagation path between the $i^{\text{th}}$ transmitting and $j^{\text{th}}$ receiving antenna, $x[k]$ is the transmitted signal, $L_{ji}$ is the channel length between the $i^{\text{th}}$ transmitting and $j^{\text{th}}$ receiving antenna and $\eta_j[k]$ is the additive noise at the $j^{\text{th}}$ receiving antenna with a data block of length $N$.

At the receiver, the cyclic prefix is removed from the received signal and the channel is estimated using CMA for efficient retrieval of the signal. The detected signal is de-mapped and de-interleaved to obtain the estimate of the transmitted signal.

### 2.1. Encoder

It is the process of converting the information from a source into symbols. In the transmitter, the Hamming code is used for encoding technique which can detect and correct the errors.

### 2.2. Interleaver

Interleaving is a method for arranging data in a non-contiguous manner for increasing performance. It is a technique commonly used in communication systems to overcome correlated channel noise such as fading or burst error. The input data are rearranged by the interleaver such that the consecutive data are spaced apart. At the receiver, the interleaved data streams

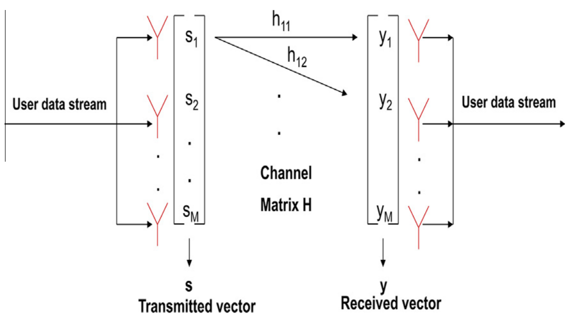


**Fig. 1.** MIMO system model.