Equalization Scheme with QPSK and MIMO in Rayleigh Channel

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Abstract

This paper addresses the joint design of transmit and receive antennas or linear processing for multicarrier MIMO channels under a variety of design criteria. Instead of considering each design criterion in a separate way, it is generalized that the existing results by developing an existing unified framework based on considering two families of objective functions that embraced most reasonable criteria to design a communication system. The inherent flexibility of the proposed transceivers is exploited to derive as special cases, zero forcing and minimum mean square filter bank and ML receiver is considered. The structure comprises a sampled linear filter. It is considered a MIMO detector to enhance the performance in MIMO channels. In this paper, the study is about MIMO systems, the spatial multiplexing with BPSK and QPSK Modulation and simulation of this structure in a Rayleigh fading channel and also with AWGN. It is needed to convert the MIMO channels to enhance the performance in MIMO systems and with Zero Forcing.

Keywords: MIMO, Spatial Multiplexing, ML, MMSE and ZF.

1. INTRODUCTION

Multiple-Input multiple-output (MIMO) channels arise in many different scenarios such as when a bundle of twisted pairs in digital subscriber lines is treated as a whole [1], when multiple antennas are used at both sides of a wireless link [2], or simply when a frequency-selective channel is properly modeled by using, for example, transmit and receive filter banks [3]. In particular, MIMO channels arising from the use of multiple antennas at both the transmitter and at the receiver have recently attracted significant interest because they provide an important increase in capacity over single-input single-output (SISO) channels under some un correlation conditions [4], [5].

Our goal is to jointly design the transmitter and receiver matrices so as to optimize the performance of a block communication system with an MMSE-BDFD. The design is based on knowledge of the channel, and hence is an appropriate choice for systems in which there is timely, reliable feedback from the receiver to the transmitter [6]. Our initial design objective is to minimize the arithmetic mean of the squared errors at the decision point (the MSE). That problem has previously been deemed to be difficult, and hence several authors have suggested minimizing the geometric mean of the squared errors (the geometric MSE) [7], which is a lower bound on the MSE. It is reasonably well known that any transmitter that minimizes the geometric MSE of an MMSE-BDFD also maximizes the Gaussian mutual information.

In this paper, it is provided that a recursive closed form expression for a choice of the above-mentioned unitary matrix degree of freedom that results in the minimization of the arithmetic MSE.[8] The resulting transceiver has many desirable properties. In addition to maximizing the mutual information between transmitter and receiver for Gaussian signals, and minimizing the arithmetic and geometric MSES, it (essentially) minimizes the bit error rate (BER) of a uniformly bit-loaded system employing QAM signaling at moderate-to-high signal to noise ratios (SNRs). The proposed design also generates uncorrelated inputs to the decision device, maximizes the minimum decision point signal-to-interference- and noise ratio over the block, and results in each element of the block having the same SINR. In particular, from within the set of transceivers, which maximize the Gaussian mutual information, it is obtained a transceiver, which provides uncorrelated inputs to the decision device, which have identical (and maximized) SINRs. Since the MMSE-BDFD is a canonical receiver [3], this suggests that by using our design, reliable communication at rates approaching the capacity of the block transmission system can be achieved using (independent instances of) the same (Gaussian) code for each element of the block.

2. SYSTEM DESIGN

Our design is based on the standard assumption that the previous symbols were correctly detected. However, error propagation is not catastrophic in block-by-block communication schemes because errors can only propagate over a single block. Our simulation studies verify that statement by indicating that the proposed transceivers perform significantly better than standard transceivers, and that they retain their performance advantages in the presence of error propagation. It is considered a generic block...
transmission model in which a block of $M$ data symbols, $s$, is linearly precoded to construct a block of $K \geq M$ channel symbols, $u = Fs$, which is transmitted over the channel. The receiver independently processes a block of $P \geq M$ received samples in order to detect the data vector $s$. The received block, $y$, can be written as

$$y = HF s + v$$

(1)

In this paper, we consider the optimal design of transceiver pair for a synchronous multiple-access MIMO system in which $K$-user data sequences are separately pre-coded and transmitted block by block at a full data rate over ISI channels. Due to its many advantages, we employ the MMSE-DF detector at the receiver of this multiple-access MIMO system. We now consider the joint optimum design of the transceivers for a multiple-access ISI MIMO system equipped with the MMSE-DFE receiver. Trying to obtain an optimum design that minimizes the MSE of the detected symbols for all $K$ transceivers while applying transmission power constraints to each user would encounter difficulties, However, since the dual water-filling algorithm allows us to have minimum transmission power for all channels given a fixed amount of mutual information, we may be able to achieve our goal of a minimum MSE design using this algorithm.[8]

$$H_{user} = \begin{bmatrix} H_1 & 0 & \ldots & 0 \\ 0 & H_2 & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \ldots & H_K \end{bmatrix}$$

$$H_{recei} = \begin{bmatrix} H^T_1 & 0 & \ldots & 0 \\ 0 & H^T_2 & \ldots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \ldots & H^T_K \end{bmatrix}$$

$$y = H_{recei} s + v$$

(2)

In this case, it is easy to see that the digital filter is given by

$$H e^{j2\pi f t} = \frac{1}{T} \sum_{n=-\infty}^{\infty} h_n(f - \frac{n}{T})$$

(3)

The proposed transceivers convert the frequency-selective channel into $-M$ independent parallel flat fading sub-channels—a decomposition reached also by [13] and [14] in the context of line and vector coding. However, our solution stem from maximizing a mutual information criterion and possesses inherent flexibility that yields as special cases zero-forcing (ZF) and minimum mean-square error (MMSE) receivers, within the class of filter banks maximizing the information rate. We also develop power and bit loading strategies aimed at maximizing the information rate, subject to constraints on fixed transmitted power and maximum tolerable bit error rate (BER).

3. SIMULATION RESULTS

In this paper, a $4 \times 3$ MIMO with BPSK and QPSK Modulation is employed as shown in fig. 2 one can see that when BPSK system is employed, it gives the best BER performance through the considered equalizers. It is cleared from the diagram below. Verify the diagram ;

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**Figure 1**: MIMO MAC with MMSE Multiuser receiver

We note that the effect of the equalizing filter on the noise is neglected in the development of the zero-forcing equalizer above. In reality, noise is always present. Although the ISI component is forced to zero, there may be a chance that the equalizing filter will greatly enhancing the noise power and hence the error performance of the resulting receiver will still be poor. To see this, let us evaluate the signal-to-noise ratio at the output of the zero-forcing equalizer when the transmission filter $H_T(f)$ is fixed and the matched filter is used as the receiving filter, i.e., signal-to-noise ratio at the output of the zero-forcing equalizer when the transmission filter $HT(f)$ is fixed and the matched filter is used as the receiving filter, i.e.,

$$H_R(f) = H_T^*(f)H_C^*(f)$$

(2)
Fig – 3: 4x3 MIMO with BPSK System

Chart - 2: 4x3 MIMO with BPSK System

<table>
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<tr>
<th>ZF SIC</th>
<th>BER</th>
<th>SNR</th>
<th>BER</th>
<th>SNR</th>
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Again we can see that this (ML with 14 dB SNR is the best configuration among all above)

4. CONCLUSION

Spatial Multiplexing schemes provide a multiplexing gain and do not require explicit orthogonalization as needed for space-time block coding. The paper compared two nonlinear interference cancellation methods Zero Forcing and Minimum-Mean-Square-Error with symbol cancellation and compares their performance with the Maximum Likelihood optimum receiver.

We have used two modulation schemes- first BPSK and second QPSK. Three equalizers we considered in our thesis are ZF, MMSE and ML. The ZF equalizer is simple and always considered as reference with the other equalizers. The other equalizer is the MMSE equalizer, is best among other equalizers. The third equalizer is the ML equalizer that is optimum equalizer with high complexity and high error detection and correction capabilities.

From the above simulation results and discussion we conclude that data recovery is much important then the time therefore spatial multiplexing techniques with BPSK modulation are suitable for high gain and for higher performance as compared to QPSK.

5. REFERENCES


