Performance Enhancement of Adaptive DFE Detector for MIMO System

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(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In this paper, we study detection techniques in Multiple Input Multiple Output (MIMO) spatial multiplexing system. This paper includes techniques like Maximum likelihood (ML), Minimum Mean Square Estimation (MMSE), and Adaptive Decision Feedback Equalizer (DFE) algorithm. The adaptive DFE detection achieves the optimal performances with reduced complexity using 4QAM modulation. The simulation result of adaptive DFE decoder shows the Bit error rate (BER) decreases as increase in the signal-to-noise ratio (SNR) as compared to the ML and MMSE equalization.

Keywords: MIMO, Spatial Multiplexing, Detection technique, Maximum likelihood detection, minimum Mean Square estimation, Adaptive DFE.

I. INTRODUCTION

MIMO systems are defined as point-to-point communication links with multiple antennas at both sides of transmitter and receiver. The use of multiple antennas at both sides clearly provides enhanced performance over diversity systems. In recent research it is observed that MIMO can significantly increase the data rates of systems without increasing the transmit power or bandwidth [1]. MIMO systems use the spatial diversity to increase data rate and spectral efficiency [2]; MIMO channels provide a number of advantages over Single Input Single Output (SISO) channels such as the array gain, the diversity gain, and the multiplexing gain. MIMO can yield significantly improve reliability of link and increase data rate without using additional bandwidth. The unique characteristic of MIMO channels is multiplexing gain. Spatial multiplexing is a transmission technique in MIMO wireless communication to transmit independent and separately encoded data signals called streams, from each of the multiple transmits antennas. Thus, spatial multiplexing is a powerful technique which increases channel capacity at higher SNR values [3-5]. There are numerous detection techniques in MIMO wireless communication such as Maximum Likelihood detection (ML); Minimum Mean Square Error Equalizer (MMSE), Adaptive Decision Feedback Equalizer (DFE).

In this paper, we propose a simple ML detection, MMSE and Adaptive DFE technique using 4-QAM modulation and results are compared. The simulation result of Adaptive DFE algorithms shows significant improvement in performance and BER compared to the ML and MMSE equalization. The main advantage of the proposed approach is significant performance improvements of detections while maintaining the low computational complexities.

II. SYSTEM MODEL

Figure 1 shows the block diagram MIMO detection technique. Detection is technique of extracting original signal from received signal. Maximum likelihood; MMSE equalizer; and Adaptive DFE, is used in proposed system. In MIMO high data rate is achieved by the mean of spatial multiplexing technique, in which independent stream of information is transmitted in parallel over the different transmitting antenna [6]. Here, we consider a MIMO flat fading channel with \( M_T \) transmitting antennas, \( M_R \) receiving antennas and \( M_R \geq M_T \). In MIMO spatial multiplexing system \( m^{th} \) information symbol \( d_m \) is transmitted directly on \( m^{th} \) transmit antenna. At a given instant of time this gives a baseband model with

\[
    r = H d + w \quad \cdots (1)
\]

The \( M_T \times 1 \) transmit vector \( d = (d_1 \ d_2 \ \ldots \ d_{MT})^T \). The channel matrix \( H \) is \( M_R \times M_T \).
d_{NL} = \arg \min_{d \in \mathcal{D}} \| r - H d \|^2. \tag{2}
the previous detector on the current received symbol [12].

To describe the adaptive DFE structure, suppose \((s_1, s_2, \ldots, s_N)\) are block of symbol and \((r_1, r_2, \ldots, r_N)\) are block of received symbol respectively. The received block is given to adaptive DFE operator, and the output of Adaptive DFE block id denoted by \((R_1, R_2, \ldots, R_N)\). The equalizer multiplies this output block with feed forward coefficient \((F_1, F_2, \ldots, F_N)\) the resulting block is given to inverse DFT, it gives the output block \((y_1, y_2, \ldots, y_N)\) on which the threshold detector bases its first decision for transmitted signal block.

After the first decision made by the receiver, the decision block is fed to feedback filter with coefficient \((B_1, B_2, \ldots, B_n)\) and an adaptive DFE is implemented at \(K^{th}\) iteration

\[
y_2 = \sum_{n=1}^{N} B_{12}^{(k)} R_{12} + \sum_{n=1}^{N} B_{2n}^{(k)} A_{2n}^{(k-1)} y_2 = 1,2, \ldots\N
\]

Where \(B_{12}^{(k)}\) and \(B_{2n}^{(k)}\) coefficients sets of feedback and feed forward filter.

**III. RESULT AND DISCUSSION**

Above Fig 2 and fig 3 shows the BER performance for 2x2 MIMO Rayleigh channel using Equalization and adaptive DFE respectively. The simulation result of both equalizers shows that Bit error rate (BER) decreases with the increase in signal to noise ratio (SNR). Fig 2, the graph shows BER \(10^{-2}\) the SNR value is \(\sim 7\)dB. Fig 3, the graph BER \(10^{-2}\) the SNR value is \(\sim 6\)dB.

**IV. CONCLUSION**

We develop the ML, MMSE and Adaptive DFE detection techniques for MIMO system, and performance are analyzed BER Vs SNR. Finally we compare the performance of equalization technique and Adaptive DFE detection technique as shown in graph BER decreases with the increase in the SNR value. The adaptive DFE gives the better compared to the equalization detection technique.

**REFERENCES**


