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RESEARCH ARTICLE

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MUTLIPLE-INPUT MULIPLE-OUTPUT (MIMO) WIRELESS SYSTEMS

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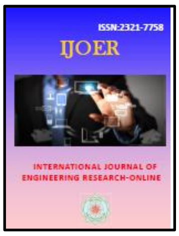

ABSTRACT

To meet the requirement of very high data rates for wireless Internet and multimedia services, multiple transmitting and multiple receiving antennas have been proposed for fourth generation wireless systems. In cellular systems, performance is limited by fading and cochannel interference from other users. Most of the current studies on multiple-input multiple-output (MIMO) systems assume that the cochannel interference is both spatially and temporally white. In this thesis, we focus on MIMO systems under both spatially and temporally colored interference. In addition, there is a growing concern about energy consumption of wireless communication systems. Thus, future wireless systems have to satisfy three main requirements: i) having a high throughput; ii) simultaneously serving many users; and iii) having less energy consumption. Massive multiple-input multiple-output (MIMO) technology, where a base station (BS) equipped with very large number of antennas (collocated or distributed) serves many users in the same time-frequency resource, can meet the above requirements, and hence, it is a promising candidate technology for next generations of wireless systems. With massive antenna arrays at the BS, for most propagation environments, the channels become favourable. Performance evaluation of binary weight book is better when compared to MRC for 2×2 MIMO system. In this work, the performance of MIMO Systems have been analyzed with transmit and receive diversity. Performance of quadrature weight book is better when compared to binary weight book for 2×2 MIMO system. Quadrature weight book for 4×4 MIMO Systems have been compared by performing simulations in MATLAB on the basis of channel rate.

1. INTRODUCTION

Multiple-Input Multiple-Output (MIMO) technology is a wireless technology that uses multiple transmitters and receivers to transfer more data at the same time. MIMO technology takes advantage of a radio-wave phenomenon called multipath where transmitted information bounces off walls, ceilings, and other objects, reaching the receiving antenna multiple times via different angles and at slightly different times[1].

Multiple-Input-Multiple-Output also known as MIMO is a very powerful technique for wireless system. MIMO structure consist of multiple antennas at both transmitter and receiver end for improving the communication performance. It provides higher capacity, throughput with improved quality of service without increasing the transmitted power of antennas[2]. The benefits provided by MIMO in wireless network are array gain, multiplexing gain and spatial diversity[3]. Array gain is the gain in signal-

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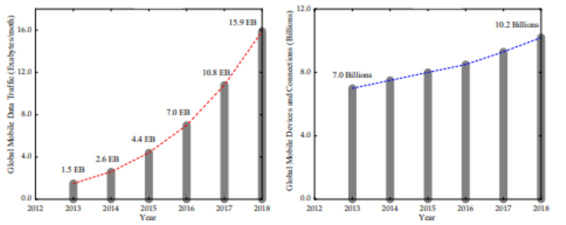
to-noise ratio due to the use of multiple antennas which leads to increased range and coverage[4].

As a result of the use of multiple antennas, MIMO wireless technology is able to considerably increase the capacity of a given channel. By increasing the number of receive and transmit antennas it is possible to linearly increase the throughput of the channel with every pair of antennas added to the system. This makes MIMO wireless technology one of the most important wireless techniques to be employed in recent years. As spectral bandwidth is becoming an ever more valuable commodity for radio communications systems, techniques are needed to use the available bandwidth more effectively. MIMO wireless technology is one of these techniques.

In wireless communication, the transmitted signals are being attenuated by fading due to multipath propagation and by shadowing due to large obstacles between the transmitter and the receiver, yielding a fundamental challenge for reliable communication. Transmission with multiple-input multiple-output (MIMO) antennas is a well-known diversity technique to enhance the reliability of the communication. Furthermore, with multiple antennas, multiple streams can be sent out and hence, we can obtain a multiplexing gain which significantly improves the communication capacity. MIMO systems have gained significant attention for the past decades, and are now being incorporated into several new generation wireless standards (e.g., LTE-Advanced, 802.16m).

Most of the current studies on MIMO systems assume that the interference is both spatially and temporally white. For example, information channel capacity of a MIMO link under both spatially and temporally white interference was assessed in[5]], channel estimation was studied in[6] and data detection was investigated in[7]. Spatially white interference means that the interfering signals on different receiving antennas are uncorrelated with the same power. Temporally white interference implies that in the decision statistics for symbol detection, the interfering signals are uncorrelated from symbol to symbol with the same power. However, in cellular systems, the interference may be both spatially and temporally colored. The spatial correlation can be explained by the simple case of one interferer: the interfering signals at different antennas are different scaled versions of the same signal, hence they are correlated. The temporal correlation may be caused by the intersymbol interference as we will explain more in the paper. Recently, MIMO systems with spatially colored interference have attracted interest. Information channel capacity of MIMO systems under spatially colored interference was studied in[8]. Performance analysis of outage and error rate for MIMO systems with cochannel interference was given in[9]. In this work, we mainly focus on MIMO systems under both spatially and temporally colored interference in slow flat fading.



(a) Global mobile data traffic. (b) Global mobile devices and connections growth.

Weight book

To achieve higher performance in MIMO systems require either complete channel knowledge at the transmitter. So to convey the information about the channel knowledge to the transmitter a feedback path is established from the transmitter to the receiver. Normally it is difficult to send whole channel as a feedback from receiver to the transmitter. Hence a weight book is designed from which the weight vector is selected depending upon the channel. This weight vector is given as a feedback instead of the channel.

GRASSMANNIAN WEIGHT BOOK DESIGN

Grassmannian line packing : Grassmannian line packing is the problem of optimally packing one dimensional subspaces. It is similar to the problem of spherical code design with one important difference: spherical codes are points on the unit sphere while Grassmannian line packing are lines passing through the origin in a vector space.

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Grassmannian line packing forms the basis for our quantized beamforming codebook design.

Problem definition

Normally it is difficult to send complete Channel information as a feedback from transmitter to receiver. Hence a Binary weight book is designed for MIMO systems using quantized feedback. Using binary weight books, the computational complexity for finding the optimum beam-forming weight vector and the storage requirement for the weight book can be reduced. The quadrature weight book which also uses quantized feedback gives better performance compared with binary weight book.

2. EXPERIMENTAL

Simulations are carried out on a PC with 2GHz dual INTEL(R) CORE(TM) i32350M processor and 6GB RAM and 750GB HARD DISK using MATLAB 7.5.0(R2007b).BER Vs SNR for binary weight book and quadrature weight book for MIMO(Multiple input and multiple output) system is performed.

3. RESULTS AND DISCUSSION

3.1 Simulation parameters

MIMO systems with M_t transmitting antennas and M_r receiver antennas is considered for BER Vs SNR performance in various scenarios. BPSK and QPSK modulations are used. Ideal synchronization between transmitter and receiver is assumed.

3.2 PERFORMANCE OF BINARY WEGHTBOOK

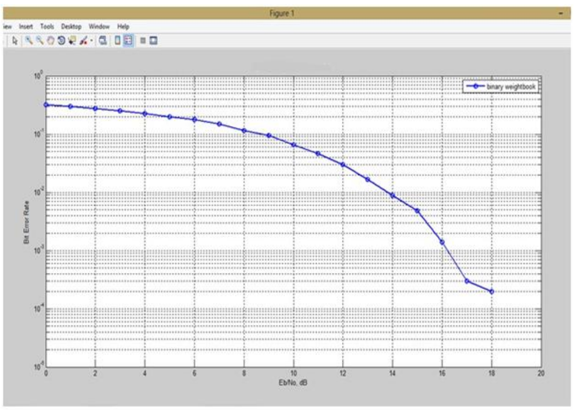

Fig.3.1.Performance of binary weight book.

Binary weight book performance in MIMO beam forming systems. Modulation scheme employed here is BPSK

3.3 COMPARISON BETWEEN PERFORMANCE OF MRC AND BINARY WEGHTBOOK WITH MRC

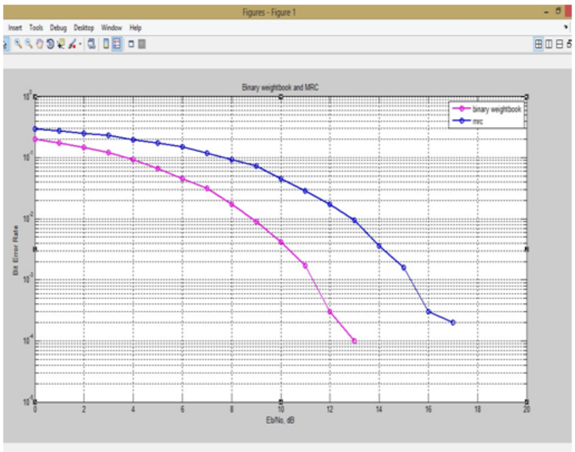

Fig.3.2: Performance comparison of MRC and binary weight book**.**

MIMO systems employing MRC and Binary weight book techniques are designed. Fig 3.2 shows Binary weight book gives better performance compared with MRC. Modulation scheme employed here is BPSK (Binary Phase Shift Keying).

3.4 PERFORMANCE OF QUADRATURE WEGHTBOOK

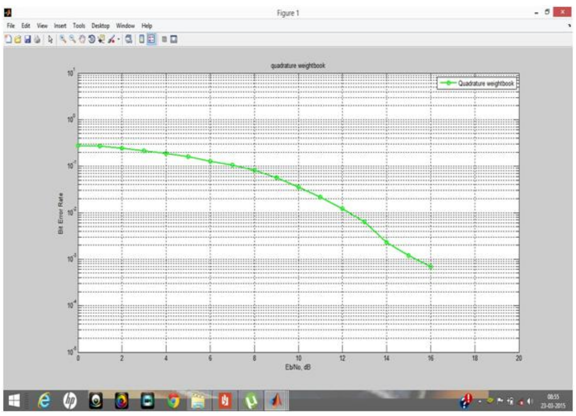

Fig.33.Performance of quadrature weight book.

quadrature weight book performance in MIMO beam forming systems modulation scheme employed here is QPSK

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3.5 COMPARISON BETWEEN PERFORMANCE OF QADRATURE WEIGHT BOOK AND BINARY WEIGHT BOOK

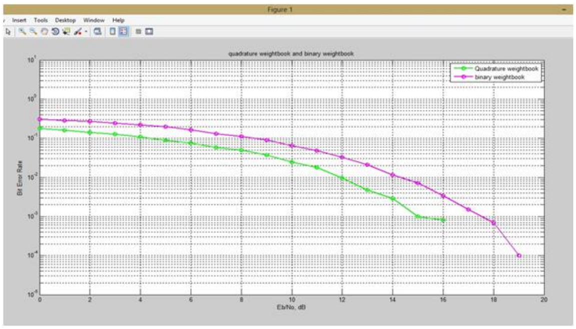

Fig.3.4.Performance comparison of binary weight book and quadrature weight book.

MIMO systems with binary weight book and quadrature weight book techniques are designed. Fig 3.5 shows quadrature weight book gives better performance compared with binary weight book.

3.6 PERFORMANCE OF QUADRATURE WEGHTBOOK FOR 4X4 MIMO SYSTEM

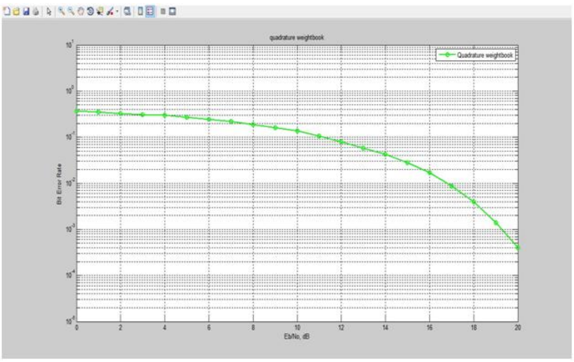

Fig.3.5: Performance of quadrature weight book 4X4 MIMO system.

Quadrature weight book performance in MIMO beamforming systems. modulation scheme employed here is QPSK

4.0 CONCLUSION

Multiple Input Multiple Output(MIMO) wireless system make use of the spatial dimension of the channel to provide considerable capacity, increased resilience to fading, or combinations of the two.

Performance evaluation of binary weight book is better when compared to MRC for 2×2 MIMO system. Performance of quadrature weight book is better when compared to binary weight book for 2×2 MIMO system. Quadrature weight book for 4×4 systems is designed.

Finally from the simulated results, quadrature weight book gives better performance compared with binary weight book and MRC. The computational complexity for finding the optimum beam forming vector is slightly increased in quadrature weight book than in binary weight book.

5.0 FUTURE SCOPE

Quadrature weight book design for MIMO-OFDM(Orthogonal Frequency Division Multiplexing) systems can achieve better performance when compared to quadrature weight book design for MIMO systems, as OFDM can be effectively mitigate Inter Symbol Interference (ISI) caused due to multipath path effect.

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