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PERFORMANCE EVALUATION OF ANTENNAS FOR ENHANCING ERGODIC CAPACITY OF CHANNEL IN WIRELESS COMMUNICATION

SUNIL D. PATIL & RUPALI V. SATPUTE

Professor, Department of Electronics and Telecommunication,

K J Somaiya Institute of Engineering and Information Technology Sion, Mumbai, Maharastra, India

ABSTRACT

Due to amplitude of signal varies with time, error rate to cease to reduce with increased SNR which faces various unfavorable effects such as fading,delay spread make it very difficult to pull off abundant data rates. High transmission data rate and stability are essential for future wireless communication system. We proposed system without needing to increase the transmitted power or the channel bandwidth, gain in capacity can be improved by varying the number of transmit as well as receive antennas on both sides.

KEYWORDS: MIMO Systems, Ergodic Capacity, SISO, SIMO, MISO, MIMO Channels, SNR

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Original Article

INTRODUCTION

A key rebel face by future generation mobile communication systems is to provide high data rate wireless contact at high superiority of service.

Multiple-input multiple-output (MIMO) wireless technology [1] seems to meet these demands by offering increased spectral efficiency through spatial multiplexing gain, and superior link reliability due to antenna multiplicity gain.

MIMO systems allow us to operate two distinct dimensions of a radio link; the first being the Diversity and the second being the Capacity.

MIMO channel capacity can be increased by adding multiple antennas at both transmitting and receiving side [2].This rising in channel capacity becomes more practical in the case where there is an adequate amount of multipath channels,.

In this paper, we will focus on the Capacity of SISO, MISO, SIMO and MIMO channels because it is a concert measure for digital communication systems and it is the maximal communication rate for which a reliable communication can be achieved.

- **MIMO Systems**

Also it can offer massive recompense over single-antenna systems, both with regard to Average capacity and error performance. MIMO systems, which use multiple Transmit as well as receive antennas for signal transmission and reception, are projected to play a major role in improving the performance of future wireless communication systems [1][2].

Wi-Fi, LTE are using the new MIMO wireless technology to offer improved link capacity combined with improved link reliability with less interference[4].

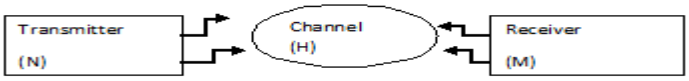

Figure 1: MIMO Channel

SISO CAPACITY

SISO system with the channel gain h, SNR the signal to noise ratio at the receiving antenna, capacity without knowing the CSI:

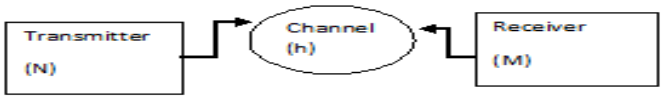

Figure 2: SISO Channel

For SISO system shown in the Figure 2, the capacity is represented by equation (2) [9].

$$C = \log_2 (1+\rho. \left| h(i) \right|^2) \text{ b/s/Hz} \quad (1)$$

The capacity increases as logarithmic function of (1+SNR)

Where ρ is called as SNR.

SIMO CAPACITY

SIMO (Single Input, Multiple Output) is single antenna at transmission and multi-antenna system at the reception. With gain between the transmit antenna and the i^{th} receiving antenna (hi), its capacity(c) of channel given by

$$C = \log_2 (1+\rho. \sum_{i=1}^{M} |h(i)|^2) \text{ b/s/Hz} \quad (2)$$

Its capacity increases with the log of $(1 + \text{SNR} \sum_{i=1}^{nt} |h(i)|^2)$ faster than in the SISO case.

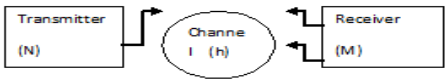

Figure 3: SIMO Channel

MISO CAPACITY

The channel capacity of the discrete-time MISO channel model is represented by (10)

$$C= \log_2 (1+\rho/nt * \sum_{i=1}^{nt} |h(i)|^2) \quad (3)$$

Where the elements hi, i= 1, 2, ,nt, represent the constant gain of the channel between the i^{th} transmitter antenna and the single receiver antenna over a symbol period and nt is the transmitted antennas. ‘’ is SNR.

Figure 4: MISO Channel

Mimo Capacity

MIMO systems offered increasing in channel capacity based on the utilization of number of antennas at both the transmitter and the receiver. Figure 1 Shows MIMO Channel.

The received signal vector (Y) is given by

$$Y= HX + n \quad (4)$$

Ergodic Capacity

By taking the group average of the information rate over the allocation of channel matrix H elements, we achieve the ergodic capacity of a MIMO channel.

MIMO ergodic capacity is represented by

$$C= \{ \log_2 (\det(I_{nr}+\rho/nt * HH^H))\} \quad (5)$$

Channel Capacity increases much faster in MIMO systems than in the SISO and SIMO case.

RESULTS

Figure 5 and figure 6 shows the capacity of SISO, SIMO,MISO and MIMO systems in terms of SNR for several values of nt and nr [12]. In the SISO case (nt = 1 and nr = 1), capacity ranges from 1 to 10 bps / Hz. It increases slowly with the SNR, which are confine of SISO. In case of MIMO (4*4),Channel Capacity ranges from 1 to 36 bps/Hz (3 times larger than SISO).

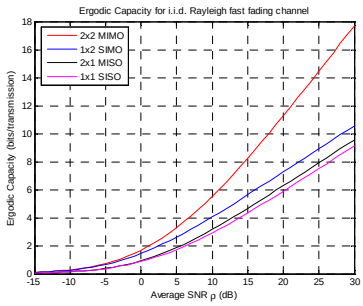

Figure 5: Comparision of Ergodic Capacity between MIMO(2*2), SIMO(1*2), MISO(2*1), SISO(1*1)

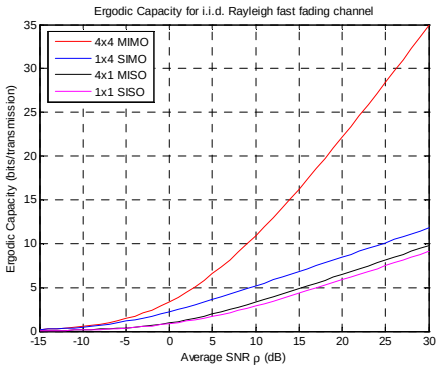

Figure 6: Comparison of Ergodic Capacity between MIMO(4*4), SIMO(1*4), MISO(4*1), SISO(1*1)

CONCLUSIONS

As increasing no. of Transmit antenna (N) and no. of Receive antenna(M), ergodic capacity of channel increases and best performance appear on MIMO than SIMO,MISO,SISO system.

We find that MIMO capacity with 4*4 is 2 times MIMO capacity with 2*2 ; MIMO capacity then increases much more rapidly with the SNR, to finish with a gain of more than 50% at 20 dB SNR.

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