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Capacity based performance analysis of optimal antenna selection for 8X8 MIMO

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Abstract: *In this paper we had simulated capacity based optimal antenna selection for 8X8 MIMO, the highest capacity is of 44bps is obtained for the selection factor 8, the capacity remains constant up to 18dB, 16dB and 12dB for L= 7,6 and 5 respectively and then increases, for L=1 to 4 the capacity increases as the SNR increases, for fading channels the selection of four antennas is enough to authorize the channel capacity as much as the use of all eight antennas in 8X8 MIMO systems.*
Index Terms: *MIMO, Antenna Selection, optimal antenna selection, channel capacity*

I. Introduction

Multiple Input Multiple Output (MIMO) technology improves the reliability of communication system in terms of error-rate performance [1-2]. The Reliable communication is more challenging due to the receiver signals from multipath may add destructively, which consequently results in a serious

Performance degradation this is due to the complexity that arises from using a separate RF chain for every employed antenna [3]. However in MIMO as Multiple antennas are employed at transmitter and receiver, the additional cost RF modules is required. In general,RF modules include low noise amplifier(LAN),frequency down-converter,and ADC [4]. In order to reduce this additional cost many researchers had work on antenna selection techniques since last decade years. Edarsh B et al. Presented Transmit antenna selection Scheme to reduce the number of RF chains, but complexity comes in the feedback channel of the TAS(Transmit antenna selection) and suggested, the complexity can be overcome by Spatial time processing and water filling strategies [5]. Single TAS is able to give the same output as given by the STBC (Space time block code) Scheme and TAS with two Transmitter antennas is equal output Alamouti code over flat fading channel [6]. RAS (Receive antenna selection) done through the optimal selection Scheme where receive antennas are selected based on the maximization of instantaneous SNR [7]. RAS is important for OFDM (Orthogonal frequency modulation technique) system where complexity in the Fast Fourier transforms and RF chains this Disadvantage is over come by Capacity –based AS for Spatial multiplexing in MIMO Systems [8]. Alexei Gorokhov et al. developed two different algorithms for joint antenna Selection at both transmitter and receiver in narrow –band MIMO systems in this first algorithm they considered the minimizing the instantaneous probability of error rate and maximizing the signal-to-noise ratio and second algorithm used as minimizing the average probability of error [9].

The rest of this paper is organized as follows. In section 2 we introduce MIMO system model with antenna selection, Antenna selection criterion for 8X8 MIMO is proposed in section 3, followed by our result and discussion in section 4 and finally conclusion.

II. Mimo System Model

Figure 1. illustrates the proposed end-to-end configuration of antenna selection of MIMIO system in which only L RF modules are used to support M_T transmit antennas(L< M_T). The the received signal y is represented by equation (1).

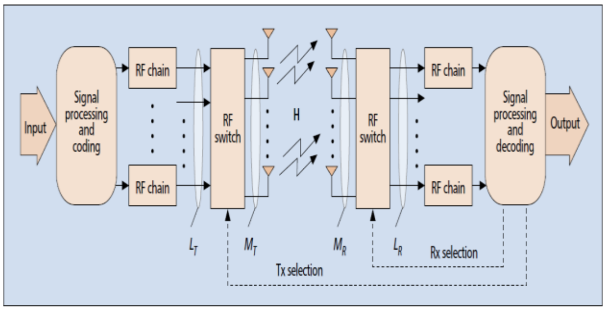

Figure 1: Antenna selection in MIMO system

$$y = \sqrt{\frac{E_X}{L}} H_{\{p1,p2,p3....pL\}}^{X+Z} \quad (1)$$

Where, the effective channel can now be represented by L columns of $H \in C^{M_R X M_T}$, p_i Denote the index of the ith selected column, i= 1,2,3,4,......,L. Then, the corresponding effective channel will be modeled by $M_T \times L$ matrix ,which is denoted by $H_{\{p_1,p_2,....,p\}} \in C^{M_R \times L}$, $X \in C^{L \times 1}$ denote the space time coded (STC) or spatial multiplexed stream that is mapped into 'L' selected antennas, $Z \in C^{M_R}$ is additive noise vector.

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The channel capacity of the system in Equation (1) will depend on which transmit antennas are chosen as well as the number of transmit antennas that are chosen [10, 11].

III. Antenna Selection Criteria

Optimal antenna selection criteria based on channel capacity is used for antenna selection in 8X8 MIMO system. In which a set of 'L' transmit antennas must be selected out of M_T transmit antennas so as maximize the channel capacity. When the total transmitted power is limited by P, the channel capacity of the system using 'L' selected transmit antennas is given by

$$C = \max_{R_{xx},\{p1,p2,....,pL\}} lo \log_2 det(I_{M_R} + \frac{E_X}{LN_O} H_{\{p1,p2,....,pL\}} R_{xx} H^H_{\{p1,p2,.....\}}) \text{ bps/Hz} \quad (2)$$

Where, R_{xx} is LXL covariance matrix, If equal power is allocated to all selected transmit antennas,$R_{xx}=I_Q$, which yield the channel capacity for the given $\{pi\}_{i=1}^{Q}$ as

$$C_{\{p1,p2,....\}} \triangleq \max_{R_{xx},\{p1,p2,....,pQ\}} lo \log_2 det(I_{N_R} + \frac{E_X}{QN_O} H_{\{p1,p2,....,pQ\}} R_{xx} H^H_{\{p1,p2,.....\}}) \text{ bps/Hz} \quad (3)$$

The optimal selection of P antennas corresponds to computing Equation (3) for all possible antenna combinations. In order to maximize the system capacity, one must choose the antenna with the highest capacity and is given as,

$$\{p_1^{opt}, p_2^{opt}, ...p_L^{opt}\} = \arg\max_{\{p1,p2,.....,pL\} \in A_L} C_{\{p1,p2,...,pL\}} \quad (4)$$

Where, $'A_L'$ represents a set of all possible antenna combinations with 'L' selected antennas, considering all possible antenna combinations in equation (4) [12, 13].

With one optimally selected antenna, as a function of the number of receive antennas, the increasing number of receive antenna elements and its performance gap between maximal ratio combiner and antenna selection becomes quite substantial [9].

IV. Result And Discussion

Figure.2 shows the channel capacity with optimal antenna selection for M_T = 8 and M_R = 8 as the number of the selected antennas varies by antenna selection factor 'L' assumed as L =1, 2, 3, 4, 5, 6, 7 and 8. The simulation is carried out for both increasing and decreasing order of antenna selection and the result for both are quite same. From the figure it is clear that the channel capacity increases in proportion to the number of the selected antennas, the capacity remains unchanged for L=8 at SNR varies from 0 to 20dB, the capacity also remains constant up to 18dB, 16dB and 14dB for L=7, 6, and 5 respectively and then it is increases as SNR increases. With L=1 to 4 as SNR increases the capacity is increases. This shows that the selection of four antennas is enough to authorize the channel capacity as much as the use of all eight antennas. The various capacity values for different 'L' as a function of SNR is illustrated in table1. From the table1 it is clear that the highest capacity of about 44bps is obtained for L=8 but this capacity value is unaffected by the SNR and is suitable for line of sight applications and L= 1 to 4 the capacity is increasing from 3.7400bps to 6.6742 as for 0dB SNR similarly from 10.2709bps to 24.88bps for 20dB SNR this shows that the capacity increases as SNR increases as well as the selection factor increases. For fading channel the selection of four antennas more is enough to warrant the channel capacity out of eight antennas in a 8X8 MIMO systems.

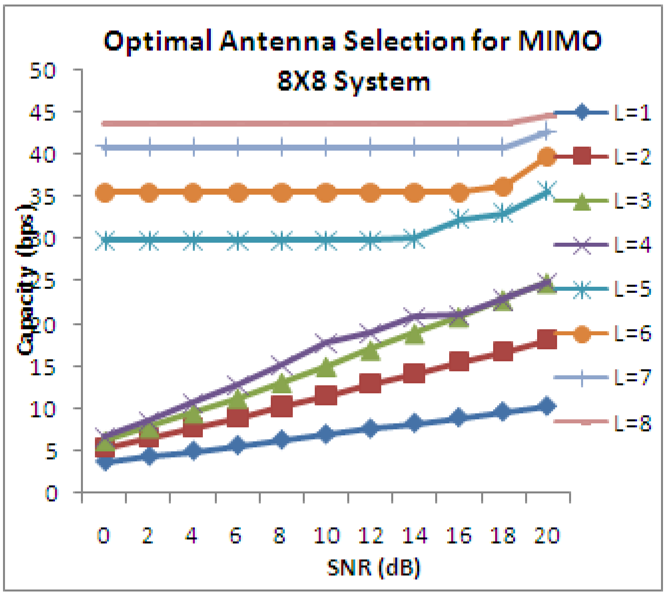

Figure 2: capacity of optimal Antenna selection for 8X8 MIMO system

Table 1: Capacity values of optimal Antenna selection in 8X8 MIMO for different antenna selection Factor L as a function of SNR

SNR (dB)	Capacity (bps)of 8X8 MIMO system							
	L=1	L=2	L=3	L=4	L=5	L=6	L=7	L=8
0	3.74	5.36	6.22	6.67	29.87	35.64	40.88	43.67
2	4.36	6.51	7.79	8.53	29.87	35.64	40.88	43.67
4	5.00	7.72	9.49	10.62	29.87	35.64	40.88	43.67
6	5.64	8.97	11.28	12.87	29.87	35.64	40.88	43.67
8	6.30	10.23	13.14	15.25	29.87	35.64	40.88	43.67
10	6.95	11.55	15.05	17.73	29.87	35.64	40.88	43.67
12	7.61	12.86	16.99	18.94	29.87	35.64	40.88	43.67
14	8.28	14.17	18.94	20.91	30.01	35.64	40.88	43.67
16	8.94	15.49	20.91	21.12	32.43	35.64	40.88	43.67
18	9.60	16.82	22.89	22.89	33.12	36.27	40.91	43.67
20	10.27	18.14	24.88	24.88	35.71	39.79	42.81	44.55

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V. Conclusion

We had simulated optimal antenna selection techniques for 8X8 MIMO system and it will provide a possibility of substantial gain increase through increasing and decreasing order by ascending or descending selection strategies with respect to antennas. It was observed that as SNR increases the capacity is increasing for four antennas and the capacity remains almost constant as a function of SNR therefore for fading channels the selection of four antennas is enough to authorize the channel capacity as much as the use of all eight antennas in 8X8 MIMO systems.

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