Optimum Antenna Selection Technique for MIMO System

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Аннотация: В этой статье был предложен метод выбора антенн в системе с несколькими входами и несколькими выходами (MIMO), который оптимизирует пропускную способность канала системы, полученную путем выбора наилучшей антенны. Метод выбора антенны может использоваться для уменьшения энергии, потребляемой на цепь RF, и повышения эффективности использования энергии для достижения максимальной пропускной способности системы MIMO. В этой статье представлены результаты отношения сигнал / шум (SNR) , которые варьируется в зависимости от количества передающих антенн, и которые должны быть выбраны в зависимости от условия канала, что обеспечивает лучшую производительность по вероятности битовой ошибки (BER).

Ключевые слова: MIMO, массивных каналах MIMO, метод выбора антенн, информацию о состоянии канала на передающей стороне (CSI), пропускной способности канала.

Abstract: This paper has proposed an antenna selection technique in multiple input multiple output (MIMO) system that optimizes the system channel capacity transmission, obtained through selection of the best antenna. The antenna selection technique can be used to reduce the energy consumed per RF chain and improve energy efficiency to achieve maximum throughput of the MIMO system. In this paper, results show that the signal-to-noise ratio (SNR) is varied with the number of transmitting antenna to be selected per channel condition, it offers a better bit error rate (BER) performance.

Keyword: MIMO, Massive channel MIMO, antenna selection technique, channel state information (CSI), channel capacity.

I. INTRODUCTION

The main challenges of future wireless communication systems are the increase of channel capacity and improved quality of service (QoS), and low-cost hardware in a large-scale system. It has been shown that multi-input-multi-output (MIMO) technology is one solution to attain this by transmitting multiple data streams from multiple antennas[1], in Fig.1, there is a system model with transmit antennas NT and receive antennas NR, where H channel can be represented by (NR x NT). However, the channel capacity (MIMO) improves with the increasing number of transmitting and receiving antennas [2]. But the main drawback of (MIMO) system is that additional high-cost (RF) chains are required as multiple antennas are employed. In general, (RF) chains include low noise amplifier (LNA), frequency down-converter, analogue-to-digital converter (ADC), and each (RF) chain contains a power amplifier (PA) contribute around 65% of the entire energy consumption [3]. Each antenna has (RF) chains. So as the number of antennas increases the number of (RF) chains will increase, which helps to increase the power consumption [4]. Therefore, cost-effective implementation of (MIMO) technology persists a major challenge. Antenna selection technique assists in reducing the implementation cost with preserving most of the benefits of (MIMO) technology by using fewer (RF) chains than the number of antenna elements, while the antenna elements are typically inexpensive, and in some cases are just a patch of copper, the (RF) chains are considerably more expensive. In antenna selection technique, a subset of the available antenna elements is adaptively chosen by a switch, and only signals from the chosen subset are processed further by the available (RF) chains [5]. The channel capacity of the system will depend on which transmitting antennas are chosen as well as the number of transmitting antennas that are chosen. Therefore, channel capacity can be increased by the antenna selection technique [6].

This technique exploits channel state information (CSI) at the transmitting side to extract almost similar benefit as of full diversity system. Other benefits of using this technique reduce the transmission energy by reducing the number of the active transmitter [7]. In addition, this technique has been used in large-scale (MIMO) system. For example, using measured massive (MIMO) channels by using two types of antenna arrays in the same realistic environment, as reported in [8]. With (massive- MIMO), we consider multi-user (MU-MIMO), where a base station is equipped with a large number (say, tens to hundreds) of antennas, and serving several single-antenna users in the same time-frequency resource. This work is aimed at increasing the capacity of the channel using the method of choosing the optimal antenna. The rest of the work is organized as follows. In Section II, the system model is described. In Section III, shows the effect of the channel correlation. In Section IV, illustrative results using the program (Matlab) package. Finally, conclusions are drawn in Section V.

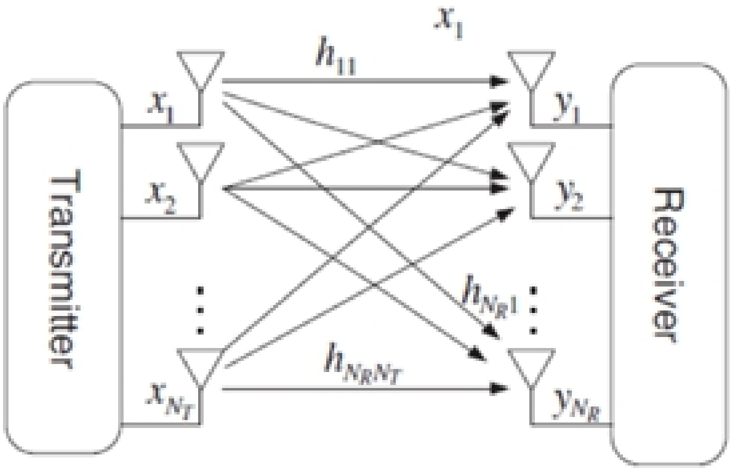


Figure 1 MIMO system (NR x NT) [illegible]

$\sqrt{\frac{P_{tx}}{Q}}$

[illegible]

C{P1,P2,…,PQ}

log2 det (INR + $\frac{P_{tx}}{Q\,N_0}$ [illegible]

[illegible] {P1,P2,…,PQ} [illegible] bps/Hz (2)

[illegible] capacity, one must pick the antenna with the greatest capacity, that is, $max_{\{P_1,P_2,\ldots,P_Q\}\in A_Q}$

Where C(P1, P2 … PQ) is a set of all possible antenna combinations with Q selected antennas

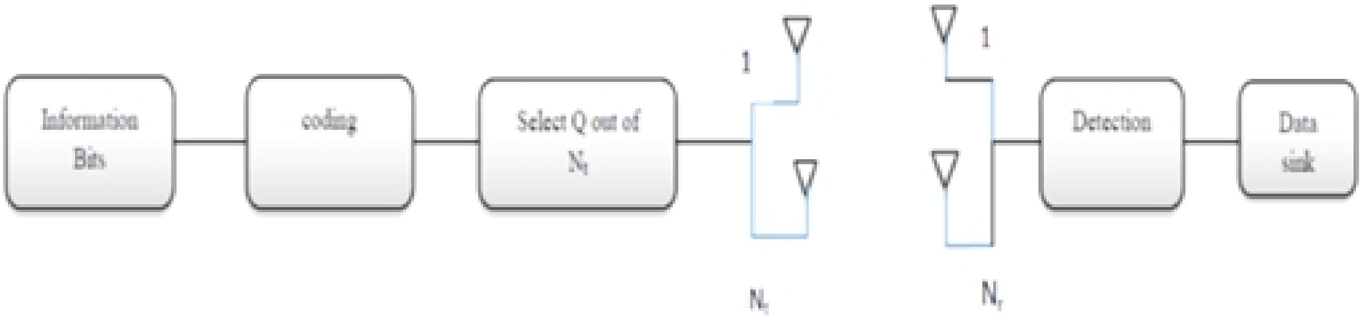


Figure 2. Antenna selections with Q with RF chains and NT transmit antennas (Q < NT).

[illegible] in order to estimate the transmitting antenna is carried out as follows:

$[H^{-1}R]$

[illegible]

$$R_{rx}=\begin{pmatrix}\alpha^{rx}_{11} & \alpha^{rx}_{12} & \cdots & \alpha^{rx}_{1N_R}\\ \alpha^{rx}_{21} & \alpha^{rx}_{22} & \cdots & \alpha^{rx}_{2N_R}\\ \vdots & \vdots & \ddots & \vdots\\ \alpha^{rx}_{N_R1} & \alpha^{rx}_{N_R2} & \cdots & \alpha^{rx}_{N_RN_R}\end{pmatrix}$$

$$\begin{pmatrix} \alpha_{11}^{rx} & \alpha_{12}^{rx} & \cdots & \alpha_{1Nr}^{rx} \\ \alpha_{21}^{rx} & \alpha_{22}^{rx} & \cdots & \alpha_{2Nr}^{rx} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{Nr1}^{rx} & \alpha_{Nr2}^{rx} & \cdots & \alpha_{NrNr}^{rx} \end{pmatrix}$$

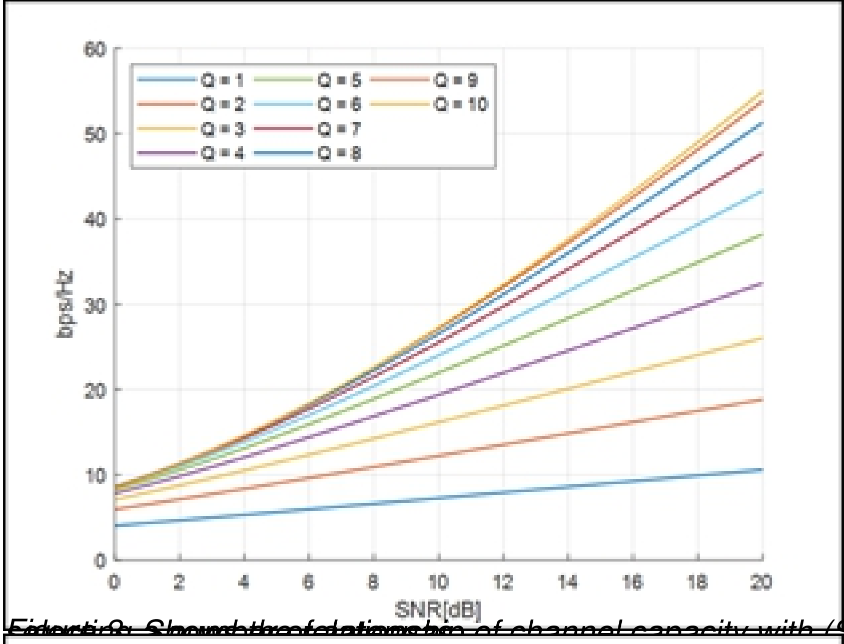
[illegible] nel matrix at delay time τ is then obtained as:

[illegible]

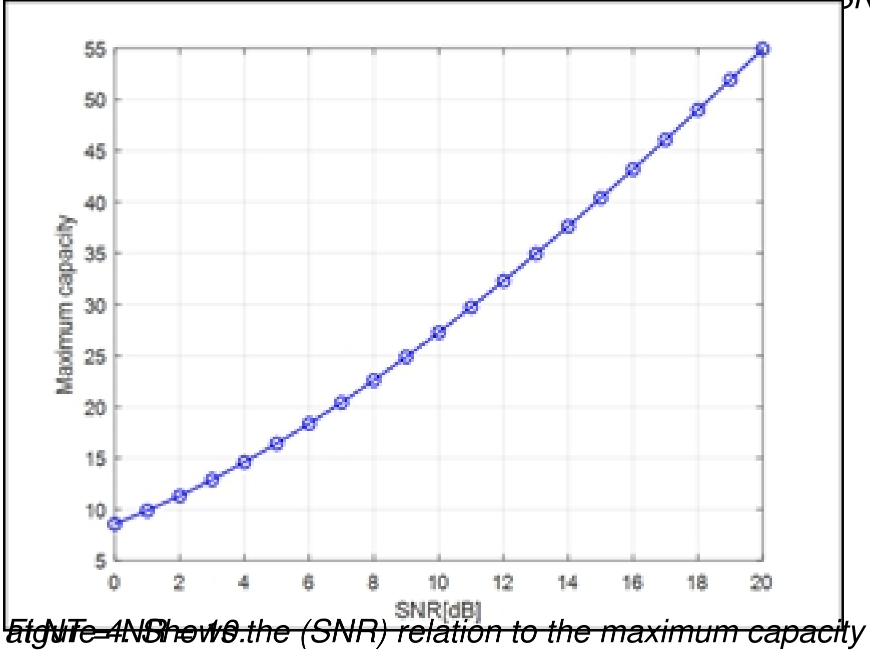
[illegible] paths assuming equal

[illegible] (7) substituting the modified channel matrix in

[illegible]



[illegible] SNR) when using the method of



[illegible] the (SNR) relation to the maximum capacity of the (MIMO) channel (bps / Hz)

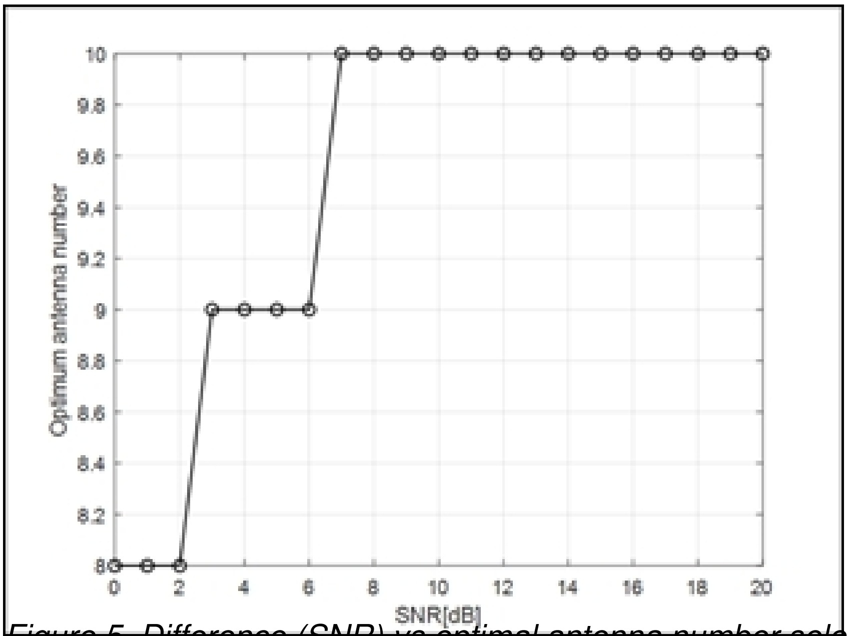
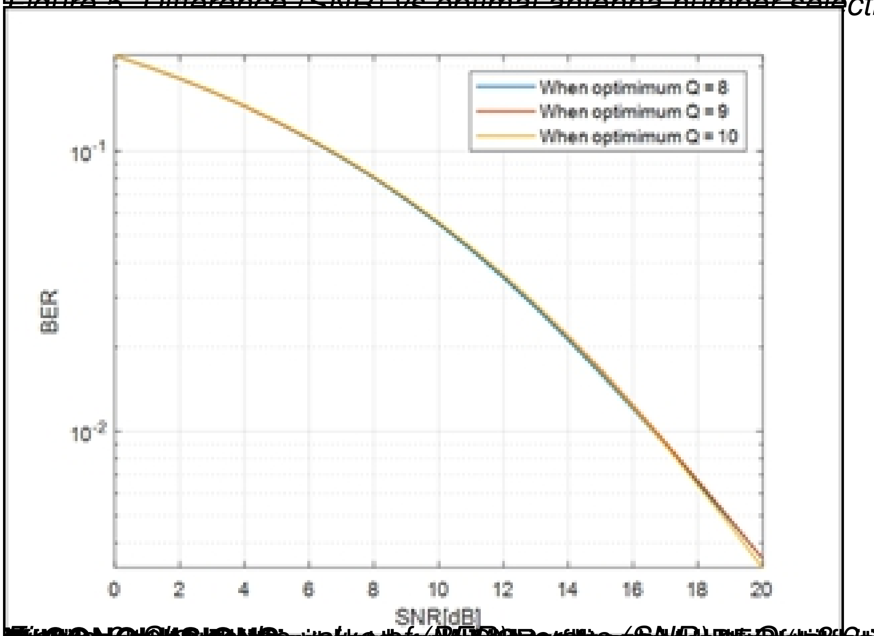


Figure 5. Difference (SNR) vs optimal antenna number selection for (MIMO) NT=NR=10.



[illegible]