Simulation of Channel Capacity for A MIMO System under Flat Fading with Different Channel Distributions

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Abstract: Multi-input multi-output (MIMO) antenna system becomes one of the hottest research topics in the communication field during the past few years due to its obvious edge over simple single antenna systems. This paper presents analyses and simulations of the effect of the channel distribution on the channel capacity for MIMO system under flat fading. Several types of distribution (Gaussian, Poisson, and Rayleigh) are considered to generate the channel matrix and determine the capacity for several cases of transmits and receiver antennas.

Keywords – MIMO, channel matrix, capacity, Gaussian distribution, Poisson distribution, Rayleigh distribution, fading.

I. INTRODUCTION

There are many factors that effect on the transmitted signal passing through communication channels that cause error in received signal comparing to that original transmitted one. These factors can be divided into deterministic in nature (such as linear and nonlinear distortion, intersymbol interference, etc.) and nondeterministic (such as addition of noise, multipath fading, ect.) [1]. The performance and capacity usually measured by bit error rate and data rate, respectively, of communication system experience degradation due to these imperfections.

Many solutions have been proposed and implemented to overcome one or more of these imperfections [2]. One of these solutions is the use of multi-input multi-output (MIMO) system that can be used to improve system performance and capacity in fading channels. During the past few years until present, many considered research efforts are conducted to deal with the MIMO system characteristics and applications [3-5]. The multiple antennas can be used to increase data rates through multiplexing or to improve performance through diversity [6]. MIMO system utilizes multiple antennas at the transmitter and receiver.

The use of multiple antennas at both the transmitter and the receiver can simply be seen as a tool to further improve the signal-to-noise/interference ratio and/or achieve additional diversity against fading, compared to the use of only multiple receive antennas or multiple transmit antennas. However, in the case of multiple antennas at both the transmitter and the receiver there is also the possibility for so-called spatial multiplexing, allowing for more efficient utilization of high signal-to-noise/interference ratios and significantly higher data rates over the radio interface [7].

In this work, the effect of multipath flat fading on the signal and how the matrix channel model distribution effect on capacity are considered. The achieved results show that the choice of channel distribution is a critical parameter in the sense of expected capacity and can be led to better modeling for different operation scenarios. The rest of the paper is outlined as follows: section 2 presents a theoretical background for the main considered distribution in the communication channels. Section 3 illustrates the achieved simulation results, then the main achieved points from this study are given in section 4.

II. THEORY

Referring to a general MIMO system showing in Fig. 1 with NT transmits antennas and NR receiver antennas.
The signal model represented as:

$$r = Hx + n \qquad (1)$$

where r is (NR x 1) received signal vector, x is (NT x 1) transmitted signal vector, n is (NT x 1) complex additive white Gaussian noise (AWGN) vector with variance equal to σ, and H is the (NR x NT) channel matrix.

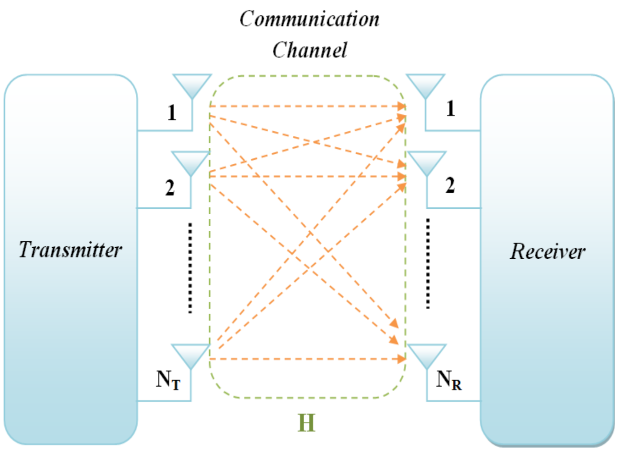

Figure 1. General MIMO system Model

The channel matrix H represents the effect of the medium on the transmitter –receiver links. The channel matrix H can be represented as follows: