Performance Analysis of Different Diversity Combining Techniques in Cooperative Wireless Communication System

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ABSTRACT:
Diversity is a powerful communication receiver technique that provides wireless link improvement at relatively low cost. This paper develops a general framework for diversity combining techniques in cooperative wireless communication system. This article, a synopsis to cover different approaches to exploiting the benefits of diversity and multihop communication via relays, such as solution for radio range extension in mobile and wireless broadband cellular network. Relaying is presented as a means to reduce infrastructure deployment costs. It is also shown that through the exploiting of spatial diversity, multihop relaying can enhance capacity in cellular network. We wish to emphasize that while this articles focuses on fixed relays, many of the concept presented can also be applied to system with moving relays.

Keywords- Cooperative diversity, fading channel, relay channel, Path loss.

I. INTRODUCTION

In wireless broadband networks cooperative communication emerged as an upgrade to single hop cellular architecture. As evident from the current and upcoming standards, there is a growing consensus in wireless community an adding multihop capability to these networks [1, 2]. Diversity is very powerful techniques robustness against channel fading. Diversity combining used to mitigate the effect of fading which consist of receiving redundancy the same information bearing signal over two or more fading channels, then combine these multiple replicas at the receiver to increase the overall received SNR. The intuition behind this concept is to exploit the low probability of concurrence of deep fades in all the diversity channels to lower the probability of error and of outage.

II. TYPES OF DIVRSITY COMBINING

There are three basic techniques for diversity combining at the receiver: selection diversity, equal-gain combining, and maximum-ratio combining. In selection diversity [10], the signal with the highest received level is switched into the receiver. In equal-gain combining [9], all received signals are coherently summed with equal amplitude and phase. In maximum-ratio combining [11], a weighted summation of signals is performed where the amplitudes are proportional to the signal-to-noise ratio (SNR) for each signal and the phase are kept equal.

A. PARAMETER OF SELECTION COMBINING TECHNIQUE

1) Outage Probability in Selection Diversity:

To analyze the bit error rate, Let us first find the outage probability on the ith receiver antenna. If the branches are independently faded, then order statistics gives cumulative distribution function (CDF) of ϒsc is given by [11].

$$P_{\gamma sc}(\Upsilon) = p(\gamma 1 < \gamma, \gamma 2 < \gamma \ldots\ldots \gamma N < \gamma) = [P_\gamma(\gamma)] \quad (1.1)$$

Rayleigh distribution is commonly used to describe the statistical time varying nature of received envelope of an individual multipath component. The Rayleigh fading distribution has a PDF in terms of received signal r_i that is

$$p(r_i) = \frac{r_t}{P_o} e^{\frac{-r_t^2}{2P_o}}$$

For "N" receive antenna which is assumed as independent. Then the outage probability for 'N'.
A branch is:

$$P_{\gamma_{SC}}(\gamma_i \leq \gamma_{th}) = \left(1 - e^{\frac{\gamma_{th}}{\gamma_0}}\right)^N \quad (1.3)$$

(1.2)

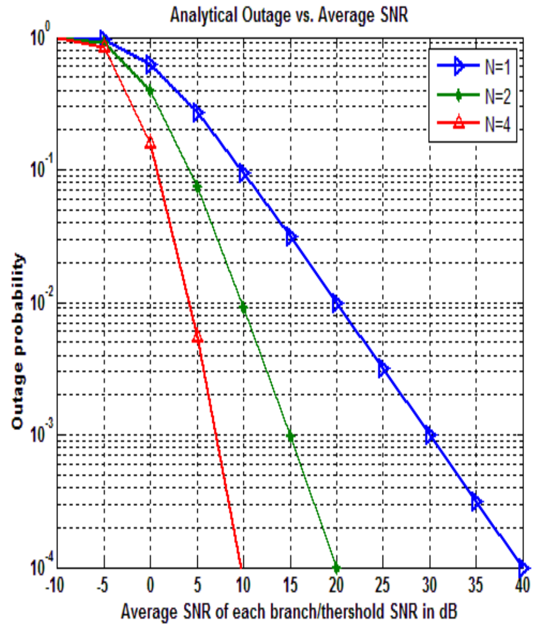

Fig.1. Outage probability vs. Average SNR by varying number of receiver antennas for N = 1, 2, 4.

2) *Calculate the average SNR, Υ_N at the combiner having N branches:*

To calculate the PDF for the "N" branches which is equal to the derivative of equation (1.3) with respect to Yth becomes

$$p_{\gamma_{SC}}(\gamma_{th}) = \frac{N}{\gamma_0}\left(1 - e^{-\frac{\gamma_{th}}{\gamma_0}}\right)^{N-1} e^{-\frac{\gamma_{th}}{\gamma_0}} \qquad (1.4)$$

So that average output bit energy to noise ratio calculate is calculated by-

$$\bar{\gamma}_{SC} = \int_0^{\infty} \gamma_{th} \, \frac{N}{\gamma_0}\left(1 - e^{-\frac{\gamma_{th}}{\gamma_0}}\right)^{N-1} e^{-\frac{\gamma_{th}}{\gamma_0}} d\gamma_{th}$$

$$= \gamma_0 * \frac{1}{k} \qquad (1.6)$$

With selection diversity we are seeing that the average SNR at the combiner is not increased linearly with increased the number of receives antennas. SC is not an optimal diversity technique because it does not use all of the possible branches simultaneously. The advantages of SC are it simple because it controls switch. We don't require perfect channel state information that is amplitude, phase, and delay. We don't require many RF changes state like RF amplifiers, noise amplifiers and power amplifiers.

$$\bar{\gamma}_{SC} \sum_{k=1}^{N} \qquad (1.5)$$

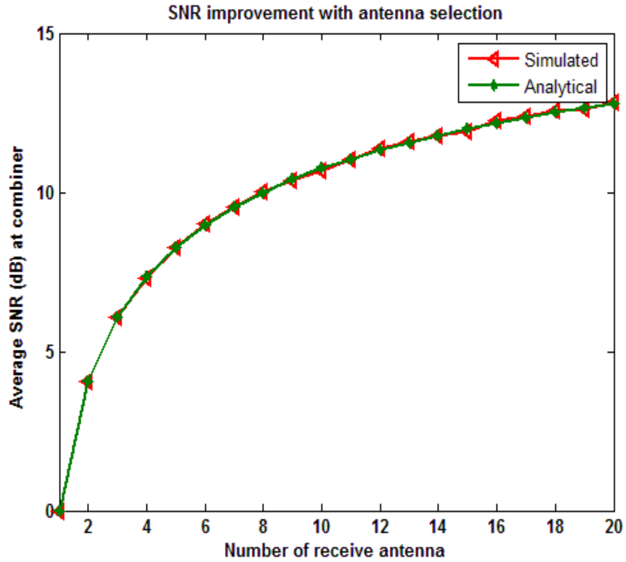

Fig.2. Average SNR at receiver vs. Number of receive antenna

From fig it's clear that with "2" receive antenna, the average SNR. Υ_N at the combiner is 1.5 times average SNR. Yo of each branch. With "3" receiver antenna, the average SNR at the combiner is 1.833 times average SNR of each branch. With "4" receiver antenna, the average SNR at combiner is 2 times average SNR of each branch.

3) *Probability of error, Pe for selection combining:*

To calculate the average probability of error at the combiner is computed by integrating the probability of error in AWGN channel after that that equation solve by using mathematica software and we get Pe.

$$P_e = \frac{1}{2}\sum_{k=0}^{N}(-1)^k \binom{N}{k}\left(1 + \frac{k}{\gamma_0}\right)^{-\frac{1}{2}} \qquad (1.7)$$

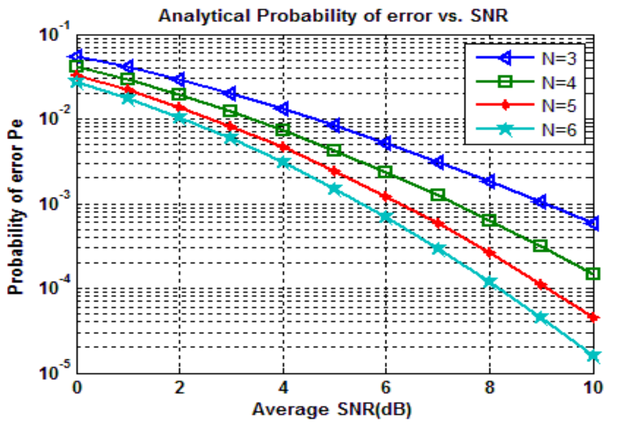

Fig.3. Analytical Pe vs. average SNR by varying no. f antennas

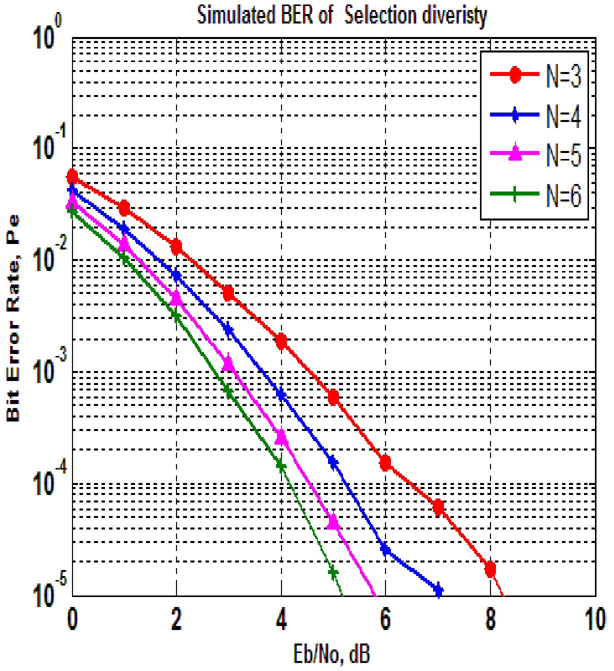

Fig.4 Simulated probability of error vs. Average SNR by varying Number of receiver antenna, N=3, 4, 5, 6

4) Comparison between Simulated and Analytical BER Result:

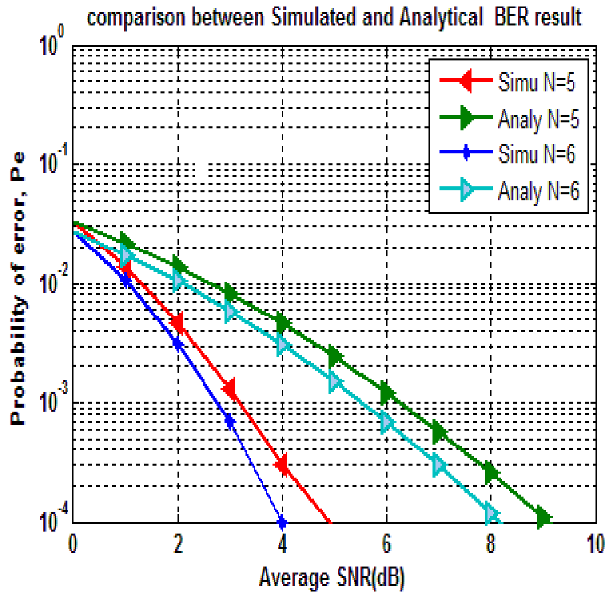

Fig.5 Analytical and simulated probability of error vs. Average SNR by varying N= 5, 6.

In SC, the output of combiner equals the signal on one of the branches. Like SC, we can analysis MRC, and OC with different parameter. In maximal-ratio combining (MRC) the output is a weighted sum of all branches.

III. AREA FOR FURTHER STUDY IN DIVERSITY TECHNIQUES:

A) Performance analysis of Joint diversity combining, Adaptive modulation, and Power control scheme [5]: Adaptive modulation and diversity combining represent very important adaptive solutions for future generations of wireless communication systems. Indeed, in order to improve the performance and the efficiency of these systems, these two techniques have been recently used jointly in new schemes named joint adaptive modulation and diversity combining (JAMDC) schemes.

B) Infrastructure-to-vehicle cooperative communication with decode-and-forward relaying [7]: In this paper, we consider infrastructure-to-vehicle cooperative communications in which roadside access points use vehicles as relaying terminals. This can be particularly useful in suburban or remote areas where the frequent deployment of roadside access points is not either possible or cost-effective. For the doubly-selective vehicular channel under consideration, we employ a pre-coded cooperative transmission technique to extract the underlying rich multipath-Doppler-spatial diversity.

C) Error performance analysis of cooperative system with receiver diversity [9]: In this paper, a cooperative system with more than one receive antenna at relay and destination is considered. Amplify and forward method is used at the relay and maximal ratio combiners are employed at the receivers. It is assumed that source-relay and relay-destination channels have Nakagami-m fading and source-destination channels have composite shadowing/fading modeled by Generalized-K distribution. The bit error performance of the system under consideration is analyzed based on the moment generating function technique and the analytical results are verified by computer simulations.

D) Predicting MIMO performance in urban microcells using ray tracing to characterizing the channel [12]: We describe a method for estimating achievable data rates in urban microcells using multiple-input/multiple-output (MIMO) techniques. Specifically, we use site maps and a versatile ray-tracing tool to compute MIMO gain matrices as a function of terminal location; and we use these matrices to determine achievable rates for various MIMO transmission modes (spatial multiplexing, beam forming, and diversity). Numerical results are generated for specific paths in Boston and Manhattan, though our results are shown to be fairly insensitive to neighborhood or city. We also show that, in urban microcells, data rate prediction using site-specific ray tracing is more informative than using stochastic models; and that adaptive switching among MIMO transmission modes as a terminal moves along its trajectory can help sustain high data rates. A new mode-switching algorithm is proposed that requires switching rates lower than those for the optimal scheme by a factor greater than 10, with little loss in average data rate.

IV. CONCLUSION

The performance of the channel can be improved using diversity combining technique and cooperative relay system in physical layer. It is intended to that the performance needs to be analyzed under cooperative environment. Firstly we will address the issues related to the channel modeling of cooperative relaying systems. We then moved on to the various mode of diversity combining techniques such as: selection combining. Finally we will explore various diversity schemes of relay based system for improving system performance.

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