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Improving Transmitter Power in MIMO Networks using Frequency Variation

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***Abstract* - Mobile high speed terminals and dispersives cause Doppler shifts, which this case creates a channel with Fast Fade. The use of multiple receiving antenna or transmitter antenna can enhance link performance such as capacity and the reliability of the channel substantially, and one of the ways to deal with Fading, is diversity. In this paper, a new method to exploit the diversity is proposed as transmission to the wireless networks, in which case, the channel state information at the transmitter does not exist. The main idea of the proposed method is time changes for the channels with slow fading. These changes are done, by adding quantized pseudo-random phases to the data symbols before sending. By using this method, the need part for processing in signal to send in the receiver, just is limited to the end of the signal modulated by the transmitter, and therefore, the implementation cost is much less than other methods.**

Keywords: Possibility of interruption, Transmission diversity, random phases, coding, quantization

I. INTRODCTIONU

One of the major issues in wireless communication is multi-path Fading phenomenon, which causes changes up and down on a small scale in received signal strength and d leads to a significant reduction in the efficiency of the system. One of the best techniques to solve this problem is providing a number of independent cases from data symbols for the receiver, so that the receiver can recovery the data correctly and with low error probability, through a combination of these types, ie the receiver can use the variation.

Variation can be used through different ways, one of which is the spatial variability. In the spatial diversity, multiple transmission and receiving antennas, to receive additional data from independent paths are used. Groundbreaking ideas of spatial variability indicate stabilization of the antennas in the receiver for use of Receive Diversity. However, as cellular networks became more popular and more popular, the demand for small, inexpensive mobile receivers causes the emergence of transmission diversity in this case, the antennas in transmitter are fixed.

To exploit the transmission diversity, the sender must use proper coding for the data symbols, or special Multiplexing[1] must be used for data symbols, which from each antenna are sent. For this purpose, a small amount of information about the state of the channel for is transmitter is provided. Transmission diversity can be classified into different categories based on the amount of information provided by the sender. In the proposed method, outage probability of the system is analyzed, achievable diversity order is calculated. Simulation results show improving the proposed scheme performance in some areas, and weaknesses of this project compared to the optimal method (Alamouti) in an area with low outage probability. This paper briefly is conducted on articles and techniques related to use of spatial diversity, with an emphasis on providing review of variety of ways to send, and then a new technique to exploit diversity is presented, where the information of channel mode in the transmitter is not used. The lack of information to the transmitter has become the proposed method to a convenient method for the wireless network. In addition, the presented method has a very low complexity and nearly optimal performance. Our proposed method is studied from the point of view of information theory. When an information theoretical analysis of a communication system is desired, the Shannon channel capacity [1] often is studied. But in the channels with slow fading, the other criterion which is called the capacity of the outage should be considered, since the Shannon capacity can not explain the behavior of this channel correctly [2].

[1] In telecommunications and computer networks, multiplexing (sometimes contracted to muxing) is a method by which multiple analog message signals or digital data streams are combined into one signal over a shared medium. The aim is to share an expensive resource. For example, in telecommunications, several telephone calls may be carried using one wire. Multiplexing originated in telegraphy in the 1870s, and is now widely applied in communications. In telephony, George Owen Squier is credited with the development of telephone carrier multiplexing in 1910.

Consequently, since it is assumed that the channel of our system has slow Fading, minimization of outage probability for a certain amount, or the maximization of outage capacity to a desired value of the likelihood outage, is our desired goal.

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II. QUANTIZED RANDOM PHASE SHIFT

Different opinions to exploit the transmission diversity based on CSIT assumption are introduced. Perfect CSIT assumption, however, leads to optimal plans, but it is generally not used. In particular, such an assumption is not realistic for a communication network, because the users are often involved in the network, and the efficient use of spectrum, is important. In wireless networks, a sender sends

the same data to many receivers, and the use of this method impose many complexities o these networks, and would be wasting bandwidth. Moreover, unlike multi cassette networks, the same data is sent to all receivers, and at least CSI for the transmitter to use a variation is not required. Then, the wireless network is considered, which uses a new method of variation with the assumption of lack of CSIT. This method is based on a class of random beam forming techniques. The main idea is similar to the random method presented in [1]. But there are two differences in this regard. First, only the random phases of the Maltese players randomly change, and their amplitude remains constant. Secondly, a quantized type of phases is used. As a result, our proposal model will benefit from the fact that the Random Maltese players can be multiplied in symbols posted on the RF communication system. This issue makes easier implementation of the method compared with other methods. A similar idea in [2] has been introduced, but only a random two-phase sample of zero and π is used, and the aim is to isolate sub-bands of adjacent OFDM.

A. System Model

Many two-antenna transmitters and single-antenna are considered. Since the receivers can receive the same data, only the performance of a receiver is studied. In addition, it is assumed that the same data on two antennas, but with different phases is sent. More specifically, one of the antennas send data symbols, whereas, other antennas multiplies each of data symbols by a randomized phase before sending them. Phases as independent and pseudo-random from a set of predefined basic form H = θ_1, θ_2, ..., $\theta_{N\theta}$ are selected in each time slot. Main channels, with slow fading, so that the channel coefficients remain unchanged for the entire communication interface. In addition, the channels between the first transmission antenna and receiving antenna and second transmission antenna and receiving antenna with the coefficients h_1 and h_2 under fading with Riley distribution are independent. In fact, the reason for use of two antennas along with random phases is that the channel becomes into a channel having fast fading. Suppose that signals and , respectively are the first and second transmission antennas and x (t) is main transmission signal. Note that, since the same data is sent on both the antenna, the total power should be divided among the antennas, ie, either of them is sent. Furthermore, θ (t) indicates the phase that accidentally is selected from the H set, and in the transmission signal, before being sent through a second antenna, is multiplied by time slot t.

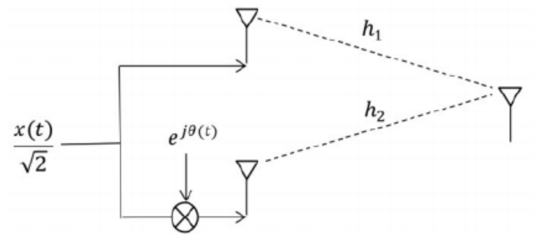
Accordingly, the received signal y (t) is obtained by the following equation:

$$y = h_1.x_1(t) + h_2.x_2(t) + w(t) = \frac{1}{\sqrt{2}}(h_1 + h_2 e^{j\theta t})x(t) + w(t) \qquad (1)$$

Where, w (t) is the noise AWGN. Note that it is obtained by using the following equation.

$$h(t) = \left(h_1 + h_2 e^{j\theta(t)}\right) \qquad (2)$$

The proposed system model has a single-antenna transmitter and a channel having fast fading and the channel coefficient h (t), which is shown in the figure below.



(1) The system model used

To select a set of random phase θ, the coefficients of the channel having a uniform distribution on (0,2π] are used and no path other than the path is preferred. Random Phases should be selected from a uniform distribution. As a result, for a fuzzy set with N_θ size, this set is determined as follows.

$$\theta = \left\{\frac{2\pi(i-1)}{N_\theta}\right\}_{i=1}^{N\theta} \qquad (3)$$

B. Probability of outage

In this section, the proposed system is analyzed from the point of view of information theory. Generally, in a system, when outage capacity is seen as a measure criteria this problem is analyzed from two different perspectives. On the first point, the transmission rate assigned is investigated, and attempts are performed to reduce the risk of amputation. Figure 2 illustrates this view. On the second point, an optimal value of the outage probability is seen, and then it is tried to increase transmission rate proportional to outage probability. In fact, the capacity of outage for a fixed amount is more than probability of outage. In Figure 3, this issue is shown from this point of view of drawing rate versus SNR for different possibilities. It can be deduced that, if the values greater than the probability of outage can be tolerated in the system, higher transmission rates will be achieved. In addition, about the possibility of constant interruption, higher SNRS leads to higher rates. Now, let us consider different number of phases in the system, and study the effect of an increase in outage capacity due to the possibility of outage. Figures (4) and (5) show the transmission rate versus SNR, by using the number of different phases, for the outage probabilities equal to 0.1 and 0.01. Figures for the three different phases N_θ = 2,4,64, are depicted. As can be deduced from these figures, increasing the number of phases leads to higher achievable rates for certain probabilities. As a result, although the use of a greater fuzzy set improves the efficiency, even two phases can be satisfactory in complexity and performance.

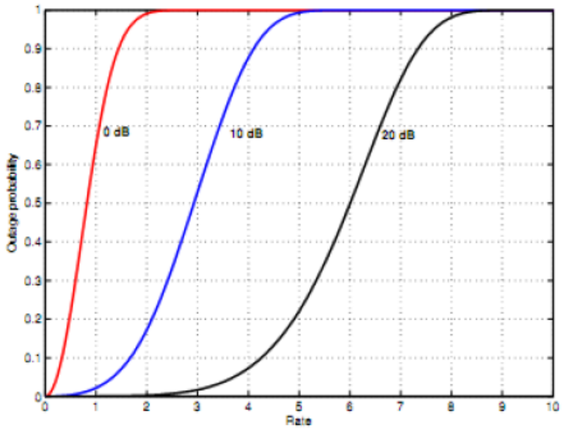


Figure (2) the possibility of Outage versus transmission rate for SNRS = 0,10,20 dB and $N_\theta = 2$

III. SIMULATION

In this section, the performance of the proposed method is compared with other methods. Single antenna method and a proposal Alamouti method are compared. By comparing the proposed scheme, and single antenna method, improving performance by adding an additional antenna to the transmitter, and the use of random phases, is observed. On the other hand, Alamouti method as an optimization scheme to exploit diversity using two antennas to send and assumes no CSIT, is considered. In fact, see what is lost about the performance using a sub-optimal method with less complexity, is important. First, the formulation of the probability of outage for single antenna method and Alamouti method is obtained. In the single antenna method, assuming the channel with Riley slow Fading, the possibility of outage is calculated as follows:

$$P_{out,signal} = prob\{c(|h|^2) < R\} = prob\{1 + (|h|^2 P) < 2^R\} = prob\left\{|h|^2 < \frac{2^R - 1}{P}\right\}$$
$$= 1 - exp\left(\frac{2^R - 1}{P}\right) \qquad (6)$$

Outage probability of the proposed scheme for the continuous phase set is always larger than the Alamouti plan. Since, the closed figure formula is not obtained for outage probability of the proposed scheme, comparison is done through simulation.

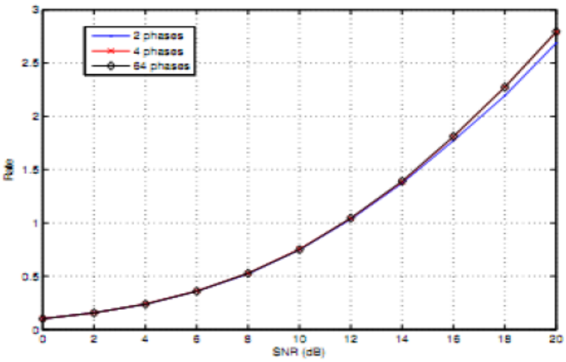


Figure 3. outage probability 0.01 and $N_\theta = 2,4,64$

Initially, for two specified amount of Outage probability, transmission rate versus SNR, for three projects will be drawn. In the proposed scheme, N_θ is equal to two.

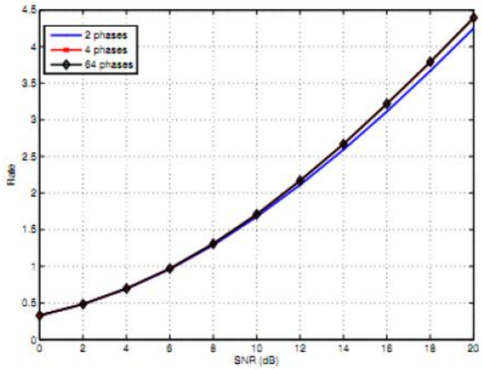


Figure 3. Outage probability 0. 1 and $N_\theta = 2,4,64$

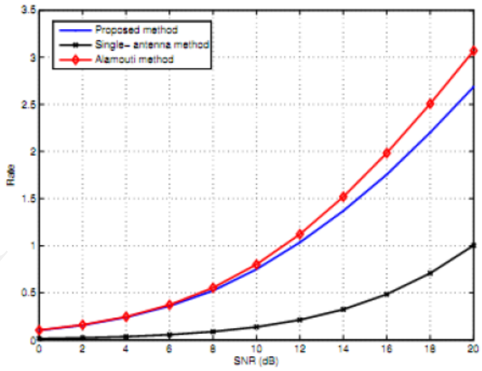


Figure 5. Transmission Rate versus SNR for the possibility of Outage 0.01 for Alamouti single antenna method and proposed method

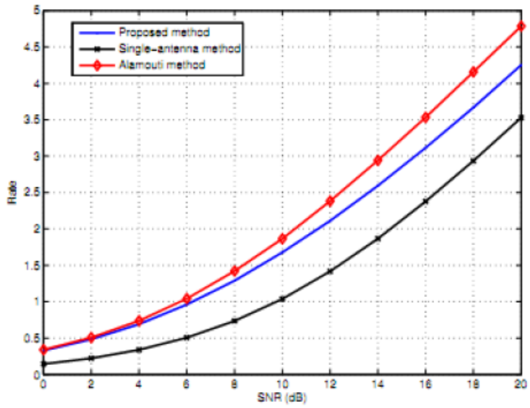


Figure 6. Transmission Rate versus SNR for the possibility of Outage 0.01 for Alamouti single antenna method and proposed method

As it is deduced from these figures, the proposed method has better performance in comparison with single antenna method, but its performance compared with the Alamouti, is superior for the specified parameters. In Figure 5, the performance of the proposed method is very close to the Alamouti method and is much better than single antenna sample. Corresponding amount is about 12 db to our proposed model, and therefore only a db gain is lost. On the other hand, SNR is almost db20 for single antenna sample (ie, about twice the recommended method) to obtain the same rates. But when, the possibility of Outage is limited to 0.01 instead of 0.1, as in Figure (6) is shown, the performance of the proposed method is closer to the single antenna model. The effect of increasing the probability of outage can be further studied by observing the probability of outage against the Transmission rate plans. It can further studied by the probability of outage against Transmission rate plans. As can be seen, when the outage probability is higher than 0.45, single antenna method has better performance than the proposed method. This scheme also has better performance than the Alamouti method, when the probability of outage is over 0.7. Although this observation seems unexpected, but it is correspond with the results of [4] and [5], in these results it is claimed that for high probability of Outage, the use of an antenna is preferred. More specifically, the boundary introduced in [5] is suitable when the use of all antennas is optimal. Given that, SNR is equal to 10 db, this boundary is reduced to R <3.45, which is shown in Figure (7). Can be seen that the Alamouti plan (as a two antennas method), compared with single- antenna method for rates less than 3.45 has better performance, while this feature is not available for the proposed project. This observation can be justified by saying that our proposal is a suboptimal plan. On the other hand, note that, for low outage probabilities, the proposed scheme has better performance compared with single antenna model and has performance very close to the optimal Alamouti plan.

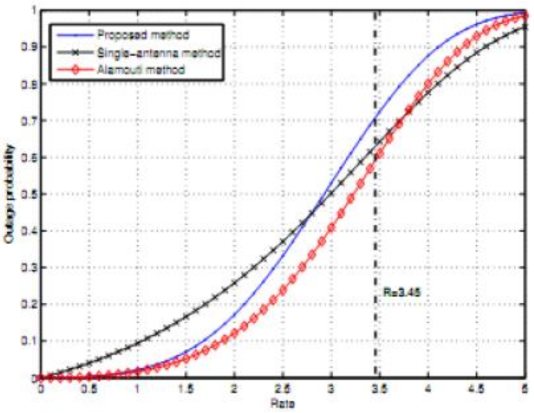


Figure 6. The possibility of outage with SNR=0.01 for single antenna, Alamouti and proposed methods

IV.CONCLUSION

Exploitation of the variety, as the most powerful method for solving multi-track Fading in wireless communication systems, is considered. Spatial diversity techniques are proper methods for channels with slow and flat fading to exploit the diversity among all methods. Comparison of the performance of the proposed method with single-antenna design represents a considerable improvement in the low possibility of outage areas. In addition, the performance of the proposed method is worse than optimized Alamouti method, so, considering the complexity of the issues, our proposal is preferred in certain cases. The diversity order of the proposed scheme is obtained. For example, for set of continuous phase, the theoretical analysis has been conducted, which indicates the variation order 2 for the scheme. As a result, this scheme exploits the order of full diversity. Simulation results have shown that the same diversity order can even be used for a random two-phase sample.

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