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Comparative Analysis of TWDP Fading Channel using Different Modulations and Diversity Combining Techniques

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Abstract: A signal propagating by means of wireless channel withstands fading effect, which debases the performance of wireless communication system. This paper focuses on the concept of fading, mainly TWDP fading with comparison over several modulations and diversity combining techniques. The phenomenon of fading requires careful scrutinization so as to get efficient data reception at the receiver side. It is a random process that occurs either due to multipath propagation or shadowing. Out of various models present, TWDP is the locus of interest –being latest and scanty work done in this field. Outage probability and average bit error rate (ABER) are accounted for in order to perform the comparison. TWDP PDF analysis is based on the expression that includes parameters such as Bessel function $I_o(.)$, fading parameters (K and) and order L. The results are obtained after simulation in MATLAB. Modulations compared are BPSK and DPSK with further collation of SC and MRC diversity technique.

Keywords: TWDP, Fading channels, SNR, MRC, SC, Outage Probability, ABER.

I. INTRODUCTION

Wireless Communication has unfolded outstandingly over the years and with the modern wireless communication techniques, the world is becoming a smaller place to live in. The design goal of wireless system is to make the received power adequate by conquering the impediments of the link. Optimisation of wireless communication system has become critical with the rapid growth of mobile services. The phenomenon which greatly affect wireless channel is fading.[11] It is the phenomenon of signal loss that occurs either due to multipath propagation or shadowing. Modelling is the most convenient approach for evaluating fading channel as it deals with the conceptual and mathematical representation of the system.[13] Many fading models have been proposed like Rayleigh, Rician, Nakagami and the latest being TWDP i.e. Two Wave Diffused Fading. The model assumes that the received signal has two relatively strong multipath components and numerous low power diffuse components.[2] TWDP fading model better represent real-world frequency selective fading data for narrowband receiver operation.

Modulation was at first introduced and is still dominant as a mode of transporting the information signal over the air. The logic is that electromagnetic waves propagate across the air if their frequency is high. This is what modulation precisely do. Modulation is the foremost method used in order to transfer the information over air. The information signal modulates high frequency signal called carrier that travels through the air. In this paper, two of the general modulation techniques, i.e. BPSK and DPSK are employed and then compared for their performance. The BPSK modulation technique is an elementary and most resilient of all PSK modulation techniques since it can handle the highest level of noise or distortion that could lead the demodulator to reach an incorrect decision. In BPSK modulation, the binary sequence is multiplied with the sine wave obtained from the oscillator to get the BPSK modulated signal. For DPSK demodulator, DPSK signal is sent to the balanced modulator and 1 bit delay circuit. The resulting signal is passed through LPF which generates binary data.

In order to further make the wireless system more efficient at the receiver side, the technique of diversity combining is used. It is a common way to combat fading and co-channel interference. Here, the receiver is provided with multiple replicas of the same information signal which are transmitted over two or more communication channels.[1] Diversity decisions are made by the receiver and are not known to the transmitter. Diversity schemes allocate two or more inputs at the receiver such that the fading method among these inputs is uncorrelated. If one radio path encounters deep fade at a particular point in time, another independent (or highly uncorrelated) path can have a strong signal at that input. The diversity combining approach hike the total received power. These methods are applied to combine various copies of the transmitted signal, which go through independent fading. The two types of diversity combining methods are hold forth here.

In selection combining scheme, the branch that gets the signal with the largest signal-to-noise ratio is picked up at any time out of a collection of antennas and coupled to the demodulator.[9] In maximum ratio combining, all the branches are utilized at the same moment. Every branch

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signal is weighted with a gain factor that is relative to its own SNR. Then co-phasing and summing is performed for accounting the weighted branch signals in phase. All the branches are weighted with their respective signal-to-noise ratios. The branches are further co-phased before summing up so as to ensure that all branches are reckoned in phase for maximum diversity gain. The summed signals are afterwards used as the received signal and sent to the demodulator.[12]

II. CHANNEL AND SYSTEM

The channel is assumed to be slow, frequency non-selective with TWDP fading statistics. The received signal over one symbol duration Ts is expressed as

$$R'(t) = re^{j¢} s(t)+ n(t),$$

where s(t) is the transmitted symbol of energy E_b and n(t) is the noise. The random variable (¢) signifies phase and r is the TWDP fading amplitude.[5]

There is no exact closed-form expression for the TWDP fading. The two parameters used to classify the shape of the TWDP PDF are $K = (V_1^2 + V_2^2) / 2\sigma^2$ and $\Delta = 2V_1V_2 / (V_1^2 + V_2^2)$, where V_1 and V_2 represent the voltage magnitudes of the two specular waves, and $2\sigma^2$ is the average power of the diffuse waves.[8] K is the ratio of the total specular power to diffuse power, while Δ parameterizes the relative strength of the two specular components.

One of the advantages of TWDP model is that it is a generalized model. By varying the value of K and Δ, other models can be formulated. [8]

K = 0	------	Rayleigh
K > 0	Δ = 0	Rician
K ⟶ ∞	Δ = 0	One wave
K ⟶ ∞	Δ > 0	Two wave

This model assumes that the received signal consists of two LOS components in addition to various non-specular components. Analysis of TWDP fading systems requires the TWDP fading PDF which is given as :-

$$\text{PDF } R(r) = (r/\sigma^2) \exp (- K - r^2/ 2 \sigma^2) \textstyle\sum a_i D(r/\sigma ; K ; a_i)$$

$$\text{where } D(z; K; a_i) = (1/2) \exp (a_i K) Io(z \sqrt{2K(1-a_i)}) +$$

$$(1/2) \exp (-a_i K) Io (z\sqrt{2K(1-a_i)}) ,$$

$a_i = \cos(\Delta\pi (i-1) / (2L-1))$, Io is the Bessel function of first kind and zeroth order, L is the order of TWDP PDF and is given as $L \geq (1/2) K$.[3][6]

III. PARAMETERS CONSIDERED

A. Outage Probability

Outage probability can be explained as the probability that the error at any particular instant will rise over a prior decided threshold or not. The moment threshold is passed-over, the value is hiked by one. [4]

It is the major figure of merit in wireless communications. In interference-limited systems, outage probability is generally explained as the probability that the signal-to-interference ratio (SIR) of a received signal is below a given threshold.

Therefore

$$\alpha = P [\ddot{\Upsilon} \leq \beta]$$

where α is Outage Probability, Ϋ is SNR , β is Threshold.

B. Average Bit Error Rate (ABER)

An expression for the ABER can be attained by dividing the overall error by number of bits for the modulation scheme employed. [2][7]

$$ABER=E [N_e / N_b]$$

where N_e= No. of errors, N_b=No. of bits transmitted.

C. Probability Density Function

It portrays the probability density of the received signal strength. The shape determines performance of wireless receiver in the presence of noise and interference and envelope represents ultimate Shannon channel capacity of a fading wireless link.

IV. RESULTS AND DISCUSSION

In this section there is discussion about the results of the proposed methodology. In this paper an approach is implemented in which the BPSK and DPSK modulation is used for MRC and SC diversity receiver. A comparison is made on the behalf of the results obtained by using the two different diversity receivers and modulations.

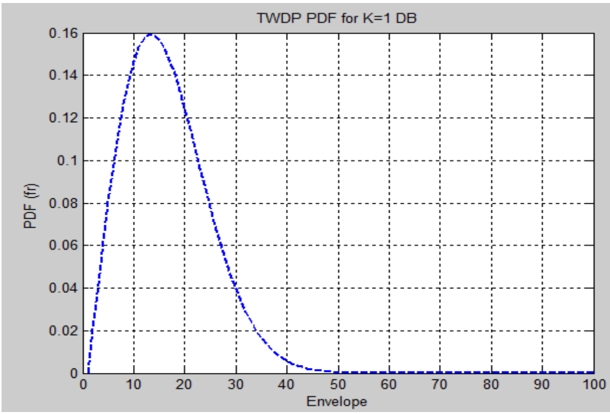

Figure 1- probability density function of TWDP fading channel for K=1.

Figure 1 depicts that all the properties of PDF are met and is clear that the power of the transmitted signal for TWDP channel concentrates over considerable range that is the desirable characteristic for an efficient system.

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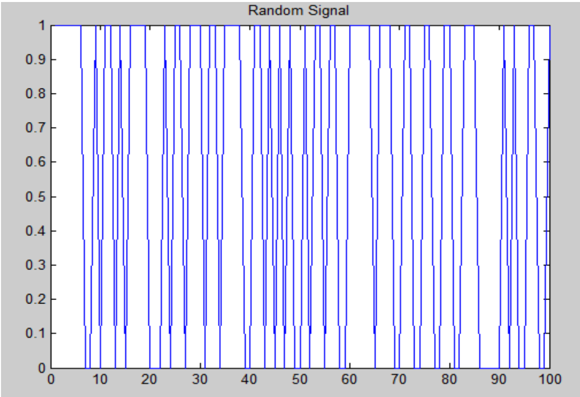

Figure 2- random signal generated initially.

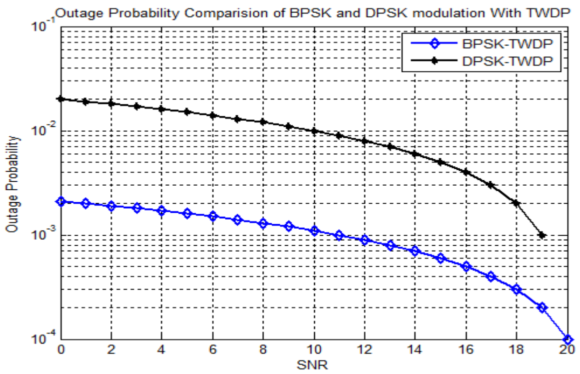

Figure 3- Comparison graph of Outage Probability of BPSK and DPSK.

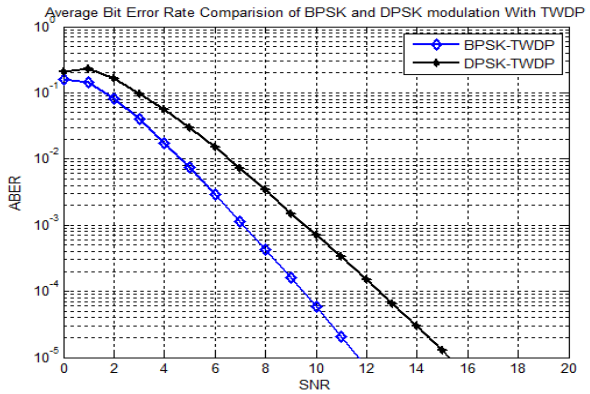

Figure 4- Comparison graph of Average Bit error rate of BPSK and DPSK

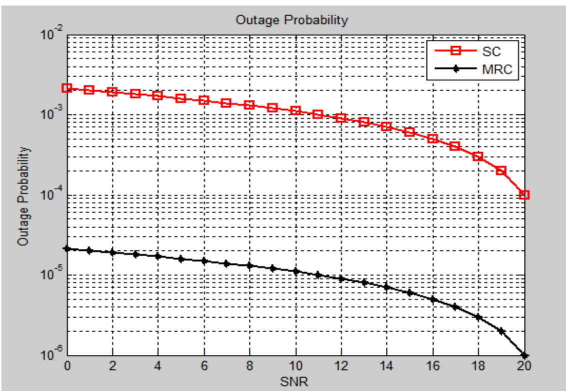

Figure 5- Comparison graph of Outage probability of SC and MRC for BPSK.

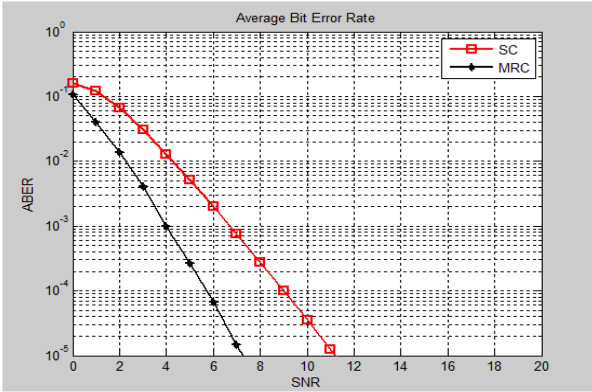

Figure 6- Comparison graph of Average Bit error rate of SC and MRC for BPSK.

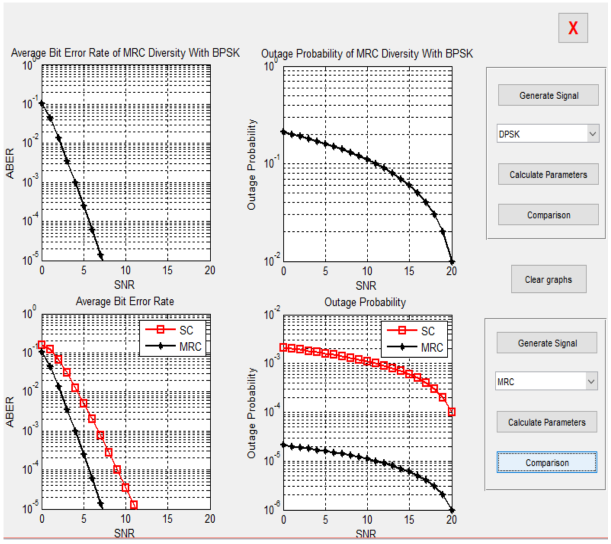

Figure 7- GUI representation.

D. References

Examples of reference items of different categories shown in the References section include:

- example of a conference paper in [1]
- example of a conference paper in [2]
- example of a journal article in [3]
- example of a standard in [4]
- example of a standard in [5]
- example of a journal article in [6]
- example of a conference paper in [7]
- example of a master's thesis in [8]
- example of a journal article in [9]
- example of a journal article in [10]
- example of a conference paper in [11]
- example of a journal article in [12]
- example of a standard in [13]

V. CONCLUSION

The proposed technique in the paper is an approach in which the BPSK and DPSK modulations are used for MRC and SC diversity receiver. The performance of SC and MRC receiver with BPSK and DPSK modulation over TWDP fading channel is analysed and results are obtained

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using MATLAB software. The parameters taken into consideration are PDF, ABER and outage probability. The numerical formulas already available are used. These parameters of interest are opted for the purpose of illustration. The quality of service provided by wireless communication system can be greatly enhanced with the help of optimum selection of modulation scheme. Thus, increased wireless coverage and decremented power consumption can be hence obtained.

Modulation is the technique that makes wireless communication possible and easy. Various other modulations are available like QPSK, QAM, M-ary that can be used to further improve the scope. More parameters can be taken into consideration. As diversity combining technique further reduces fading effects, EGC or any other new technique can be considered for improvement.[10]

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