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ANALYSING THE BER OF VARIOUS MODULATION SCHEMES

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ABSTRACT

An interesting approach for implementing diversity is space–time trellis coding, where symbols are encoded according to the antennas through which they are simultaneously transmitted and are decoded using a maximum likelihood decoder. This scheme is very effective, as it combines the benefits of forward error correction (FEC) coding and diversity transmission to provide considerable performance gains. The cost for this scheme is additional processing, which increases exponentially as a function of bandwidth efficiency (bits/s/Hz) and the required diversity order. Therefore, for some applications it may not be practical or cost-effective.

KEYWORDS: Diversity, FEC, coding, efficiency.

INTRODUCTION

A simple transmit diversity scheme which improves the signal quality at the receiver on one side of the link by simple processing across two transmit antennas on the opposite side is given by Alamouti [1]. The obtained diversity order is equal to applying maximal-ratio receiver combining (MRRC) with two antennas at the receiver. The scheme may easily be generalized to two transmit antennas and N receive antennas to provide a diversity order of 2N. This is done without any feedback from the receiver to the transmitter and with small computation complexity. The scheme requires no bandwidth expansion, as redundancy is applied in space across multiple antennas, not in time or frequency.

The new transmit diversity scheme can improve the error performance, data rate, or capacity of wireless communications systems [8]. The decreased sensitivity to fading may allow the use of higher level modulation schemes to increase the effective data rate, or smaller reuse factors in a multi cell environment to increase system capacity. The scheme may also be used to increase the range or the coverage area of wireless systems. In other words, the new scheme is effective in all of the applications where system capacity is limited by multipath fading and, hence, may be a simple and cost-effective way to address the market demands for quality and efficiency without a complete redesign of existing systems. Furthermore, the scheme seems to be a superb candidate for next-generation wireless systems as it effectively reduces the effect of fading at the remote units using multiple transmit antennas at the base stations.

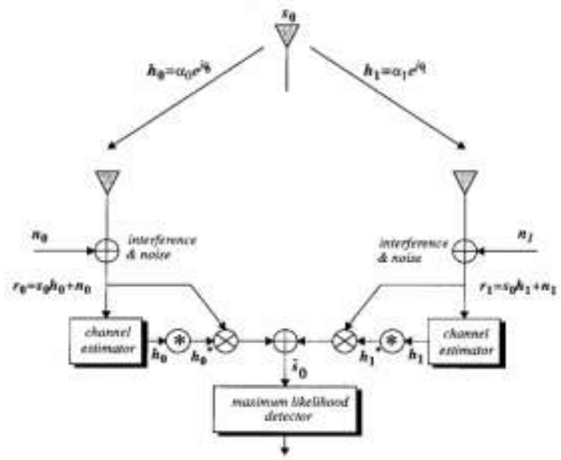
Classical Maximal-Ratio Receive Combining (MRRC)

At a given time, a signal is sent from the transmitter. The channel including the effects of the transmit chain, the air link, and the receive chain may be modeled by a complex multiplicative distortion composed of a magnitude response and a phase response. The channel between the transmit antenna and the receive antenna zero is denoted by h_0 and between the transmit antenna and the receive antenna one is denoted by h_1 where Noise and interference are added at the two receivers. The resulting received baseband signals are

$$r_0 = h_0 s_0 + n_0 \quad (1)$$

$$r_1 = h_1 s_0 + n_1 \quad (2)$$

where n_0 and n_1 represent complex noise and interference.



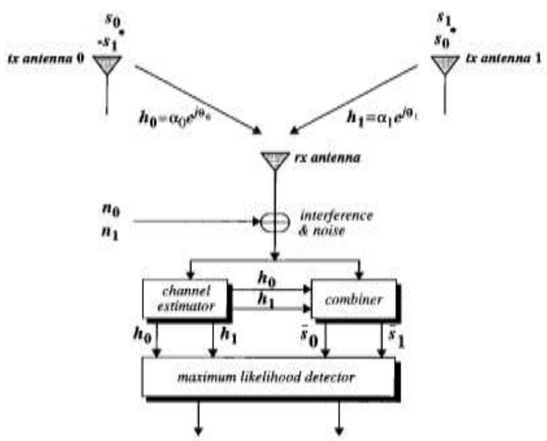
The baseband representation of the classical two-branch MRRC.

$d^2(x,y)$ is the squared Euclidean distance between signals and calculated by the following expression:

$$d^2(x,y) = (x-y)(x^* - y^*) \quad (3)$$

The maximal-ratio combiner may then construct the signal, so that the maximum likelihood detector may produce s_0, which is a maximum likelihood estimate of s_0.

The Alamouti's Transmit Diversity Scheme:



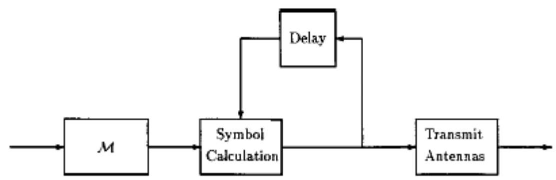
Two-branch transmit diversity scheme with one receiver.

The baseband representation of the two-branch transmit diversity scheme is shown in fig. The scheme uses two transmit antennas and one receive antenna and may be defined by the following three functions:

1. The encoding and transmission sequence of information symbols at the transmitter;
2. The combining scheme at the receiver;
3. The decision rule for maximum likelihood detection.

1) The Encoding and Transmission Sequence: At a given 0 symbol period, two signals are simultaneously transmitted from the two antennas. The signal transmitted from antenna zero is denoted by s_0 and from antenna one by s_1. During the next symbol period signal $(-s^*)$ is transmitted from antenna zero, and signal * is transmitted from antenna one.

The Encoding algorithm



Encoding scheme for Differential Detection

The first part is to choose a set of A and B which satisfy the above properties. We can calculate them by calculating all possible combinations of $(x_1\ x_2)$ and $(x_3\ x_4)$ and then using the equations to calculate the values of A and B. We then choose mapping bits onto these constellation symbols. Given a block B of 2b bits, the first b bits are mapped into a constellation symbol a_3 and the second bits are mapped into a constellation symbol a_4 using Gray mapping. The transmitter subsequently encodes the rest of the data in an inductive manner. At time 2t+1 a block of 2b bits B_{2t+1} arrives at the encoder. The transmitter uses the mapping M and computes $M(B_{2t+1}) = (A(B_{2t+1})\ \ B(B_{2t+1}))$

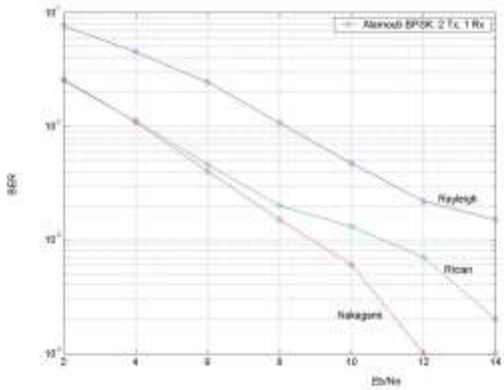
Then it computes

$$(s_{2t+1}\ s_{2t+2}) = A(B_{2t+1})(s_{2t-1}\ s_{2t}) + B(B_{2t+1})(-s_{2t}'\ s_{2t-1}') \quad (4)$$

SIMULATION

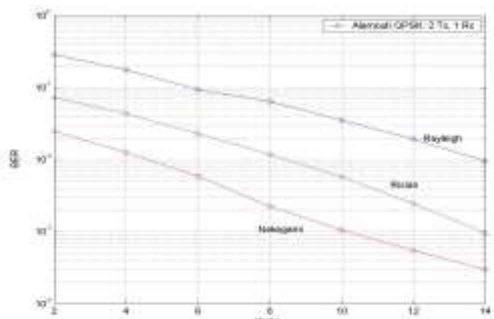
Simulations for checking the BER performance have been done on Matlab. Here first random bit stream are generated then correspondingly symbols are generated that are supposed to be transmitted to send the information of the bit stream. Then a channel is modeled for multipath fading environment. The symbols are estimated at the receiver using ML detection. The system performance is checked at different values of SNR and different modulation schemes have been used.

Simulation results of BER for BPSK under different fading environments for Alamouti's Scheme.



The BER error performance of BPSK for different fading environments.

Simulation results of BER for QPSK under different fading environments for Alamouti's Scheme.

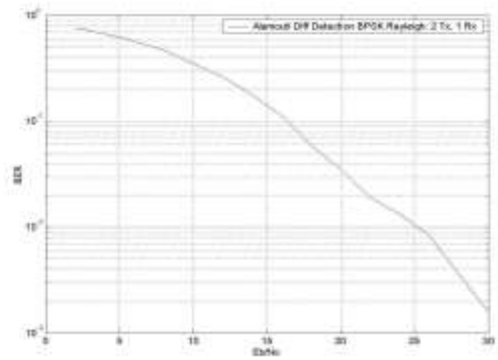


The BER error performance of QPSK under different fading environments.

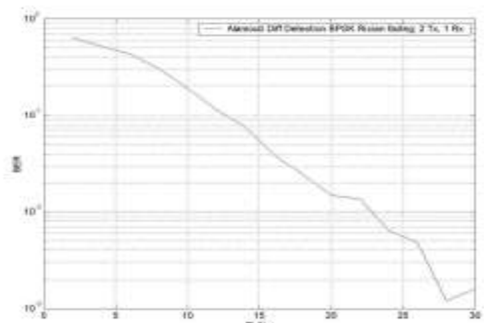
Simulations for calculating the BER performance have been done on Matlab. Here first a random bit stream is generated. Then signal power level is defined and using the encoding scheme the symbols are generated that are supposed to be transmitted. The encoded symbols are transmitted through multipath faded channel. Here channel is assumed to be flat faded and channel distortion is assumed to be multipath. The channel is generated as CN(m,N) where CN stands for circularly symmetric Gaussian random variable, m is mean and N is variance. The symbols are estimated at the receiver using ML detection. Then AWGN is added in the system which is generated using normally distributed and generated as N(0,1), where N stands for normally distributed RV with 0 mean and variance 1. The system performance is then checked at different values of SNR and for different modulation schemes.10,000 symbols are generated for each simulation and then the BER Vs SNR curves are plotted. Then comparison is done between different modulation schemes under same fading environment and also performance comparison is done for a single modulation scheme under different fading environments. The system comparison is done between the Alamouti's scheme and the Differential Detection Transmit Diversity.

RESULTS

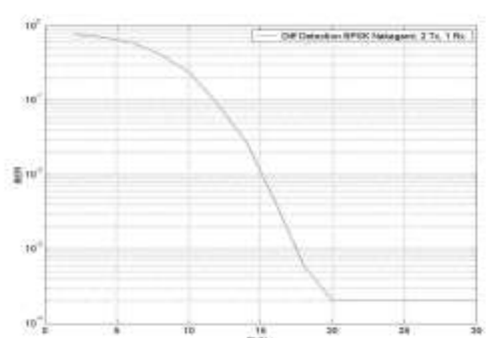
Simulation results of BER for BPSK under different fading environments with Differential Detection Scheme.



The BER error performance of BPSK for Rayleigh fading



The BER error performance of BPSK for Rician fading.



The BER error performance of BPSK for Nakagami fading.

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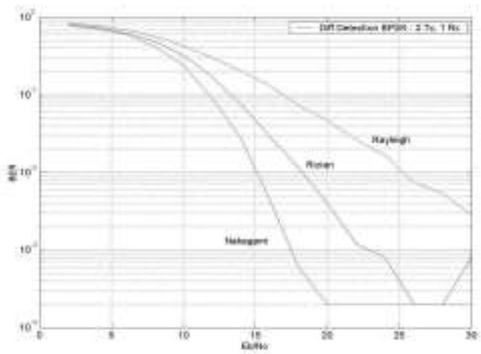
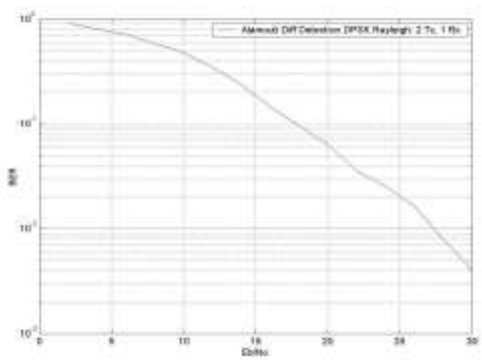


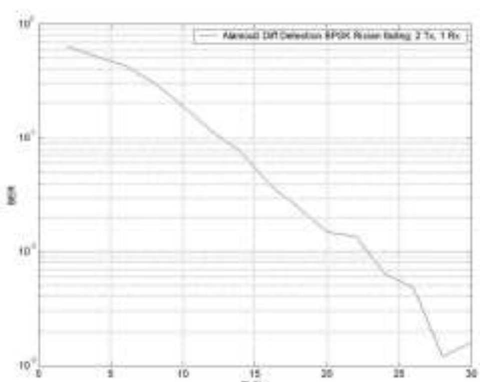
The BER error performance of BPSK for Different fading environments.

It has been seen that the system performance using BPSK is best under Nakagami fading. For a BER of 0.01, the system under Nakagami fading requires a SNR of 15dB and under Rician fading it requires a SNR of 18dB and under Rayleigh it requires a SNR of 25dB.

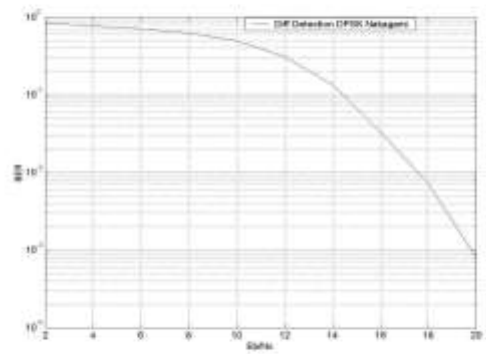
Simulation results of BER for DPSK under different fading environments with Differential Detection Scheme.



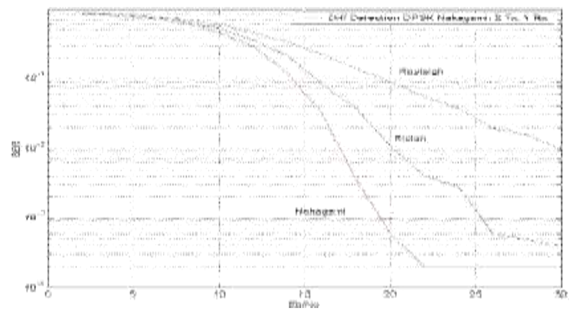
The BER error performance of DPSK for Rayleigh fading.



The BER error performance of DPSK for Rician fading.



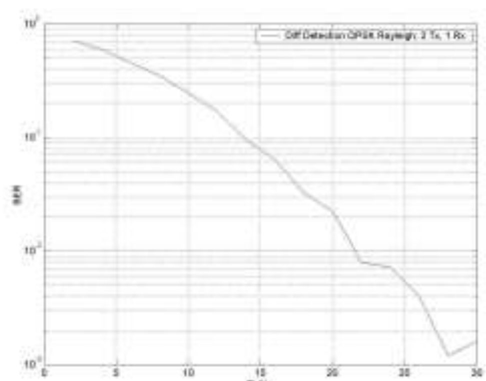
The BER error performance of DPSK for Nakagami fading.



The BER error performance of DPSK for Different fading environments.

It has been seen that the system performance using BPSK is best under Nakagami fading. For a BER of 0.01, the system under Nakagami fading requires a SNR of 15dB and under Rician fading it requires a SNR of 18dB and under Rayleigh it requires a SNR of 25dB.

Simulation results of BER for QPSK under different fading environments with Differential Detection Scheme



The BER error performance of QPSK for Rayleigh fading.

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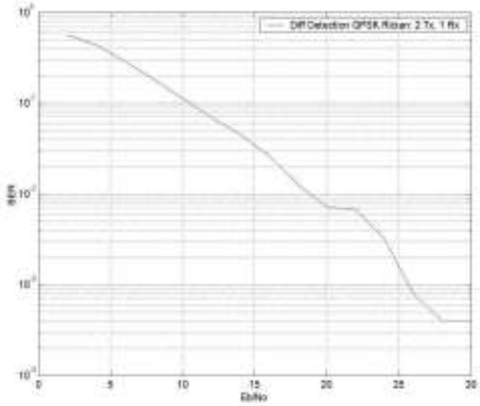
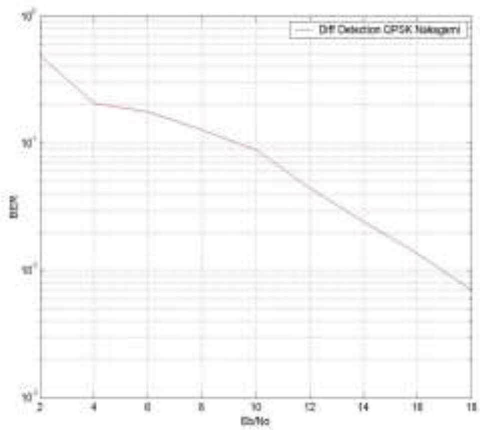
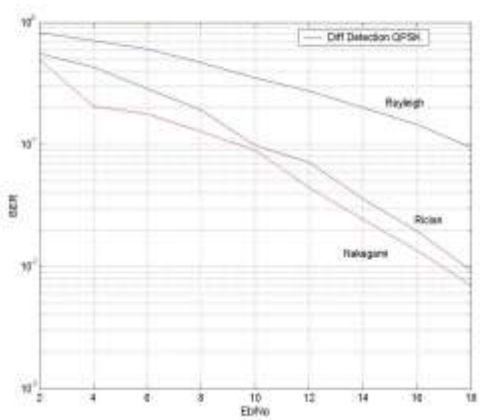


The BER error performance of QPSK for Rician fading.



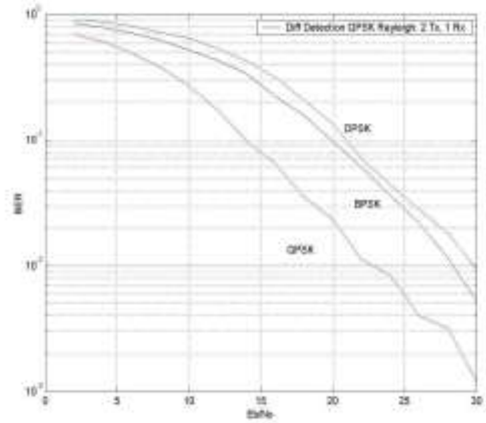
The BER error performance of QPSK for Nakagami fading.



The BER error performance of QPSK for Different fading environments.

From the above figures it has been seen that the BER performance of the system at an SNR of 12dB for Nakagami is 0.0178, for Rician it is 0.0398 and for Rayleigh it is 0.1585. Hence the performance of the system is comparative under Nakagami and Rician fading schemes.

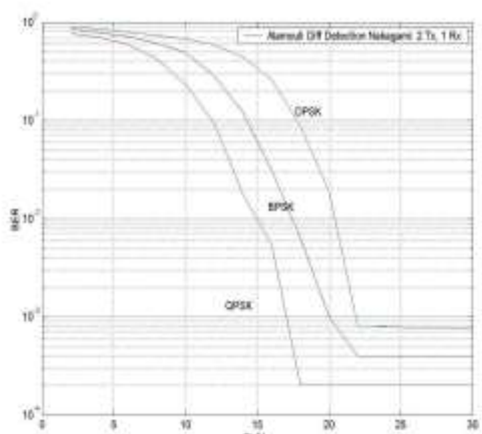
Comparison of BER of different modulation schemes with Differential Detection Scheme under Rayleigh fading environment.



The BER error performance of different modulation schemes under Rayleigh fading.

This performance comparison of the system is done under Rayleigh fading using different modulation techniques. At a BER of .01 the SNR required by QPSK modulation scheme is 22dB, for BPSK at the same BER the required SNR is 27dB and for DPSK it is 30dB. Hence in order to get same BER performance, QPSK requires the least value of SNR.

Comparison of BER of different modulation schemes for Differential Detection Scheme under Nakagami fading environment.

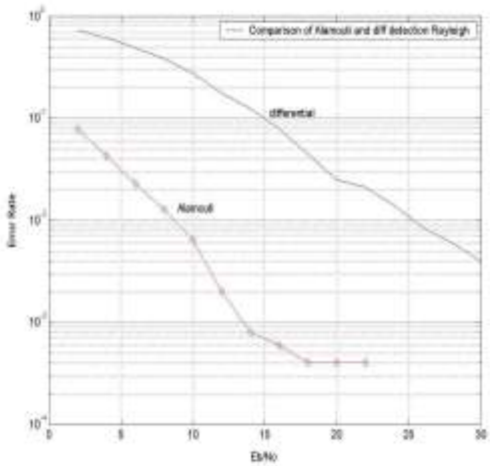


The BER error performance of different modulation schemes under Nakagami Fading.

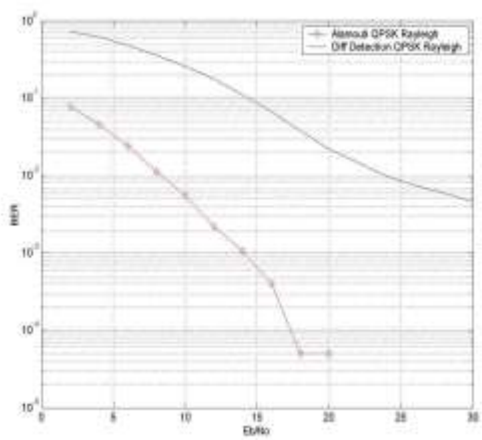
It is observed that the performance of the system is better using QPSK scheme compared to BPSK and

DPSK schemes. At a BER of .01 the SNR required by QPSK modulation scheme is 15dB, for BPSK at the same BER the required SNR is 17dB and for DPSK it is 21dB. Hence in order to get same BER performance, QPSK requires the least value of SNR.

Comparison of Differential Detection Scheme and Alamouti's Scheme using BPSK and QPSK under Rayleigh fading.



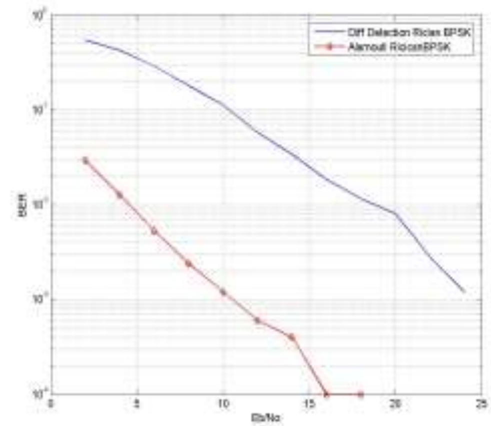
Comparison of Differential Detection Scheme and Alamouti's Scheme using BPSK under Rayleigh fading.



Comparison of Differential Detection Scheme and Alamouti's Scheme using QPSK under Rayleigh fading.

The above figure shows the comparison of differential detection scheme and Alamouti's scheme using QPSK under Rayleigh Fading. In this figure the performance comparison has been done between Alamouti's scheme and Diff detection transmit diversity technique using BPSK modulation and under Rayleigh fading. For a BER performance of 0.01 the Alamouti's scheme requires a SNR value of 8dB and Diff detection scheme requires a SNR of 25dB.

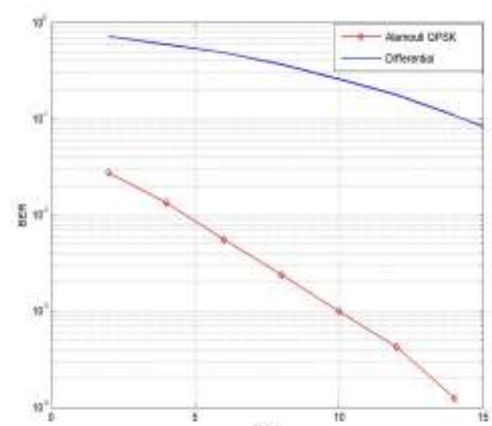
Comparison of Differential Detection Scheme and Alamouti's Scheme using BPSK under Rician fading.



Comparison of Differential Detection Scheme and Alamouti's Scheme using BPSK under Rician fading.

The performance comparison has been done between Alamouti's scheme and Diff detection transmit diversity technique using BPSK modulation and under Rician fading. For a SNR of 15dB the Alamouti's scheme gives a BER of .0004 and for the same value of SNR the Diff detection scheme gives a BER of 0.0501.

Comparison of Differential Detection Scheme and Alamouti's Scheme using QPSK under Rician fading.



Comparison of Differential Detection Scheme and Alamouti's Scheme usingQPSK under Rician fading.

The performance comparison has been done between Alamouti's scheme and Diff detection

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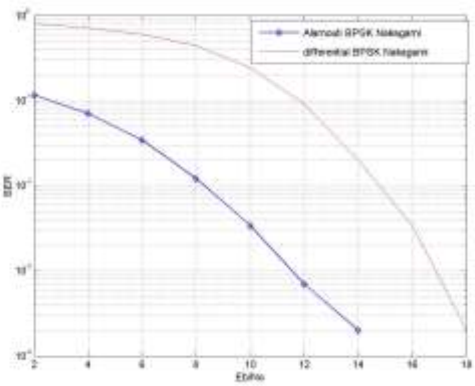
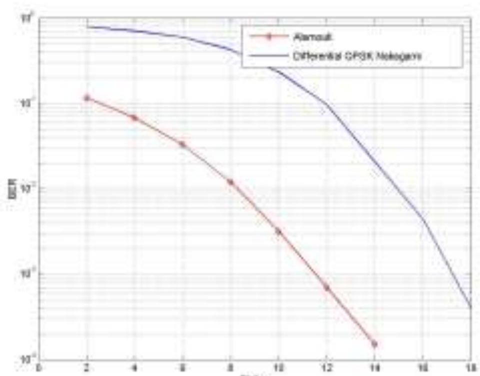
transmit diversity technique using QPSK modulation and under Rician fading. For a SNR of 5dB the Alamouti's scheme gives a BER of .0032 and for the same value of SNR the Diff detection scheme gives a BER of 0.1413.

Comparison of Differential Detection Scheme and Alamouti's Scheme using BPSK and QPSK under Nakagami fading.



Comparison of Differential Detection Scheme and Alamouti's Scheme using BPSK under Nakagami fading.

The performance comparison has been done between Alamouti's scheme and Diff detection transmit diversity technique using BPSK modulation and under Nakagami fading. For a BER value of 0.01 the Alamouti's scheme requires a SNR value of 8dB and the Diff detection scheme requires a value of 15dB.



Comparison of Differential Detection Scheme and Alamouti's Scheme using QPSK under Nakagami fading.

The performance comparison has been done between Alamouti's scheme and Diff detection transmit diversity technique using QPSK modulation and under Nakagami fading. For a BER value of 0.01 the Alamouti's scheme requires a SNR value of 8dB and the Diff detection scheme requires a value of 15dB.

CONCLUSION

In the simulation 2 transmit antennas and 1 receive antenna system is used. It is found that the BER performance of Alamouti's scheme is better as compared to differential Detection transmit diversity but the advantage with using differential detection is that there is no need to have the channel information at the receiver or transmitter side. Moreover the system complexity with using a differential scheme is less as compared to Alamouti's scheme. So differential detection method should be preferred where there is no need for a higher BER performance as it will reduce system complexity.

The simulation results show that the performance of a QPSK system is better as compared to BPSK and DPSK modulation techniques. Also it is found that Nakagami fading gives best approximation for the channel as it gives the best performance among all the fadings considered. The DPSK gives the least BER but it has the advantage thatthe system does not require any channel information at the transmitter for DPSK systems.

The performance of the Alamouti's system using QPSK modulation under Nakagami fading gives BER performance of 0.0120 at a SNR of 15dB and the Differential Detection Transmit Diversity scheme gives a BER performance of 0.302. The simulation results show that the BER performance of the Alamouti's scheme is better but the advantage with using the Differential Detection Transmit diversity scheme is that in this scheme there is no need for channel estimation in the second scheme. This reduces the system complexity as there is no need for extra hardware to estimate the channel.

REFERENCES

1. *Wei Yu and John M. Cioffi*, **'**On Constant Power Water-filling**'**, Electrical Engineering Department,Stanford University, Stanford, @2013, CA94305, U.S.A.
2. *Xiwu Lv, Kaihua Liu, Yongtao Ma*, 'some results on the capacity of rayleigh fading channel', School of Electronic and Information Engineering, Tianjin University, Tianjin, China, 978-1-4244-3709-2/10/ ©2012, IEEE.
3. *Ke Xiao, Zemin Liu*, **'**Constrained Capacity and Power Allocation for MIMO Rayleigh Fading Channels'**,**college of telecommunication engineering,Beijing University of Posts and Telecommunications @2011.
4. *Symeon Chatzinotas, Muhammad Ali Imran, Reza Hoshyar*,'On the Ergodic Capacity of

the Wideband MIMO Channel' Centre for Communication Systems Research University of Surrey, United Kingdom, GU2 7XH. 978-1-4244-2517-4/09/©2010 IEEE.

5. *Rongtao Xu, Zhangdui Zhong, Jiann-Mou Chen*, 'Approximation to the Capacity of Rician Fading MIMO Channels', State Key Laboratory of Rail Traffic Control and Safety, Beijing Jiaotong University, China. 978-1-4244-2517-4/09/©2009 IEEE
6. *Ying Wang and Dian-Wu Yue*, Member, IEEE,'Capacity of Rayleigh Fading Channels in the Presence of Interference'. IEEE Transactions on Vehicular Technology,Vol. 58, No. 8, OCTOBER 200
7. *Caijun Zhong, Kai-Kit Wong*, Shi Jin,'on the ergodic capacity of MIMO Nakagami Fading Channels'Adastral Park Research Campus, University College London. 978-1-4244-2571-6/08/ ©2008 IEEE.
8. *Sellathurai*_Space-Time Layered Information Processing for Wireless Communications. 2009 by John Wiley & Sons.
9. *M.Jankiraman* Space-Time Codes and MIMO Systems. 2004 ARTECH HOUSE.
10. MIMO Wireless Communications by *Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, Arogyaswami Paulraj & H Vincent Poor*. Cambridge University Press 2007.
11. MIMO_ Space-Time Code Design by *claude Oestgesand Bruno Clerckx*.
12. *Rueywen Liu*, Life Fellow, 'The Ultimate Capacity of MIMO Channels and its Realization'University of Notre Dame. 1-4244-1342-7/07/ ©2007 IEEE.
13. P. J. Smith and M. Shafi, "Waterfilling methods for MIMO systems," in 3rd Australian Communications Theory Workshop (AusCTW), Canberra, Australia, Feb. 4-5, 2002, pp. 33–37.
14. G.J. Foschini, M.J. Gans, "On limits of wireless communication in a fadingenvironment when using multiple antennas," *Wireless Personal Communications*,vol. 6, no. 3, pp. 311-335, Mar. 1998.
15. I.E. Telatar, "Capacity of multi-antenna gaussian channels," Europea Transactions on Telecommunications, vol. 10, no. 6, pp. 585-595, 1999. D. G. Brennan, "Linear diversity combining techniques", Proceedings of the IEEE vol. 91, no. 2, pp. 331-356, Feb. 2003.
16. S.M. Alamouti, "A simple transmit diversity technique for wireless communication IEEE J. Select. Areas Commun., vol. 16, no. 8, pp. 1451–1458, Oct. 1998.