Journal of Theoretical and Applied Information Technology
15th September 2011. Vol. 31 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A GENERALISED SPACE TIME SUM-OF-SQUARES SELECTION SCHEME FOR ALAMOUTI MIMO SYSTEMS USING MPSK MODULATION SCHEME

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ABSTRACT

Multiple-antenna systems are currently enjoying increasing popularity and widespread applications in which, it can improve the capacity and reliability of wireless receiver section. MIMO systems utilize multiple antennas to increase the diversity gain of wireless communication systems. Space Time Block Coding (STBC) is a MIMO-based algorithm, which efficiently exploits spatial and temporal diversity. In this paper , the analytical results for the bit error rate (BER) of M-ary Phase Shift Keying(MPSK) in a slow ,flat Rayleigh fading channel for a multiple-input multiple-output (MIMO) system using an Alamouti transmission scheme and Maximal Ratio Combining scheme is studied and simulated using matlab tool box.This paper analyses the performance of Generalized Space-time sum of squares (GSTSoS) receiver section scheme. The simulation results show that as the number of receivers is increased the Bit Error Rate(BER) of the system is decreased.

Keywords: *Multiple-Input Multiple-Output (MIMO), Log Likely Ratio (LLR) Selection, Maximal Ratio Combiner(MRC),Signal To Noise Ration (SNR), Space–Time Sum-Of-Squares (Stsos) Selection*

1. INTRODUCTION

In conventional wireless communications, a single antenna is used at the source, and another single antenna is used at the destination. In some cases, this gives rise to problems with multipath effects. A MIMO wireless communication is a promising technology to enhance capacity and robustness of the link by the presence of multiple transmits antennas and multiple receive antennas in the communication link. The use of multiple antennas at both ends improves spectral efficiency and link reliability. MIMO technology has attracted attention in wireless communications, because it offers significant increase in data throughput and link range without additional bandwidth or transmit power. When an electromagnetic field (EM field) is met with obstructions ,the wave fronts are scattered, and thus they take many paths to reach the destination. The late arrival of scattered portions of the signal causes problems called as fading.

2. SYSTEM MODEL

Alamouti Coding is a STBC which exploits the diversity scheme in the transmitter side for a two transmitter system. At a given symbol duration, two signals are simultaneously transmitted by two antenna .If 'S_1' and 'S_2' are the two symbols then symbols transmitted from the first antenna are '$-S_2$*' and 'S_1' and from second antenna the symbols are 'S_1*' and 'S_2'.

Consider a system where an Alamouti scheme is applied with 2 Tx antennas and *L* Rx antennas with MPSK modulation. Each receiver antenna responds to each transmitter antenna through a fading channel coefficient. The received signals are corrupted by additive noise that is statistically independent among the N receiver antennas and the symbol periods. The corresponding received signals in these two intervals on the *i*th branch can be expressed as

$$r_{1,i} = g_{1,i}\, s_1 + g_{2,i}\, s_2 + n_{1,i} \quad \text{............ (1a)}$$

$$r_{2,i} = -g_{1,i}\, s_2^{*} + g_{2,i}\, s_1^{*} + n_{2,i} \quad \text{............ (1b)}$$

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where

$g_{j,i}$, $j = 1,2$, $i = 1, \cdots ,L$ is the complex gain between the jth Tx antenna and the ith Rx antenna,

$n_{j,i}$, $j = 1,2$, $i = 1, \cdots ,L$ represents additive channel noise.

The complex channel gains $\mathbf{g}_{j,i}$ are estimated at the Rx prior to fading compensation. The variances of the real (or imaginary) components of $g_{j,i}$ and $n_{j,i}$ are denoted by σ_g^2 and σ_n^2 respectively. The average SNR per symbol of the received signal is defined as $\overline{\Upsilon} = 2\sigma_g^2/\sigma_n^2$.

At the receiver, the received signal from each Rx antenna is first processed by a space-time (ST) combiner which computes the receiver decision variables

$y_{1,i} = \hat{g}_{1,I}^{*} r_{1,I} + \hat{g}_{,i} r_{2,I}^{*}$ --------------------------.(2a)

$y_{2,i} = \hat{g}_{,i}^{*} r_{1,I} - \hat{g}_{1,i} r_{2,I}^{*}$-----------------------------------.(2b)

where

$\hat{g}_{j,i}$ is the estimate of $g_{j,i}$ with variance $\sigma_{\hat{g}}^2$, in the real and imaginary part. Then the SNRs of the output signals are measured and the Ls out of L signals with the largest SNRs are selected and combined by a MRC combiner. The signal estimate is based on the phase of the MRC combiner output,

$\Sigma \; y_{j,i}$, $j=1,2$ $(i=1 \text{ to } Ls)$

with equal SNRs over the Rx branches assumed.

Since both log likely ratio (LLR) selection and SNR selection schemes require channel knowledge, a new selection scheme, referred to as space–time sum-of-squares (STSoS) selection. The STSoS selection scheme does not require knowledge of the channel gains to make the Rx antenna selection. Furthermore, branch selection is done before the space–time decoding, so that channel estimation for the space–time decoding is only performed for the branch selected, achieving a significant complexity reduction.This STSoS SC scheme requires squaring the amplitudes of the received bit signals.

The figure No 1 shows the system model of GSTSoS selection combining scheme. In the transmitter side the information to be transmitted is converted into symbols s1, s2. Here we use two transmitters since alamouti scheme is been used. At time instant't' the two symbols s1, s2 are transmitted through two antennas. Again at time instant 't+T', the negative conjugate of s2 ($-s_2^*$) and conjugate of s_1 (s_1^*) are transmitted through the same antennas. In the receiver side, the symbols transmitted by both the antennas are received by each of the 'L' receiver antennas. Then the SNRs of the received signals are measured and Ls out of L signals with the largest SNRs are selected. The selected signals are then processed using Space-time combiner and then combined in an MRC combiner.

Fig: 1 The MIMO system using an Alamouti scheme and GSTSoS.

$2r_{1,i}^{\;2} + 2r_{2,i}^{\;2}$

$= |r_{1,i} + r_{2,i}|^2 + |r_{1,i} + r_{2,i}|^2$

$= |g_{1,i}(s_1 - s_2) + g_{2,i}(s_1 + s_2) + n_{1,i} + n_{2,i}|^2 +$

$|g_{1,i}(s_1 + s_2) + g_{2,i}(s_2 - s_1) + n_{1,i} - n_{2,i}|^2$

and, observe further that $s_1+s_2=2$ and $s_1-s_2=0$ or $s_1+s_2=0$ and $s_2-s_1=+/-\,2$ so that

$= |r_{1,i} + r_{2,i}|^2 + |r_{1,i} + r_{2,i}|^2$

$$= \begin{cases} |\pm 2g_{1,i} + n_{1,i} + n_{2,i}|^2 + |\pm 2g_{2,i} + n_{1,i} - n_{2,i}|^2 & , s_1 = -s_2 \\ |\pm 2g_{2,i} + n_{1,i} + n_{2,i}|^2 + |\pm 2g_{1,i} + n_{1,i} - n_{2,i}|^2 & , s_1 = -s_2 \end{cases}$$

Thus, selecting the branch having the maximum value of $r_{1,i}^2 + |r_{2,i}|2$ is equivalent to selecting the branch with the maximum value of

$|g_{1,i} + n_1^e|^2 + g_{2,i} + n_2^{e\,2}$

where n_1^e and n_2^e are independent, complex noise samples, each of variance $\sigma_n^2/2$ in each of the real and imaginary components.

3. SIMULATION RESULTS AND DISCUSSIONS

The simulations are carried out in the signal processing lab..Figure No 2 shows the Performance comparison of GSTSoS scheme by varying the no of receivers.

Figure no 2: Performance comparison of GSTSoS scheme by varying the no of receivers

The number of transmitters are kept as two and varying the number of receivers as 2,4,8,16,32,64,128,256 the performance is analyzed. It is inferred that as the number of receivers is increased the Bit Error Rate(BER) of the system is decreased. Better performance can be achieved by having more number of receivers.Figure no 3 shows the bar chart for the above simulation result.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Figure no 3 Bargraph Performance comparison of GSTSoS scheme by varying the no of receivers .

Further the simulation results show the performance of GSTSoS selection combining scheme for varying number of strongest diversity branches. The number of transmitters is kept as two and the number of receivers as 16, varying the number of strongest diversity branches as 2, 4, 8, 16. It is shows that as the number of the selected branches is increased the Bit Error Rate(BER) of the system is decreased.

Figure No 4: Performance comparison of GSTSoS for various no. of strongest diversity branches(L_s)

Figure No 5: Bar graph Performance comparison of GSTSoS for various no. of strongest diversity branches(L_s)

4.ACKNOWLEDGEMENTS

The authors express their sincere thanks to The management,The director (Academics),The principal and The HOD/ECE of Sri Ramakrishna Engineering College, Coimbatore-22,T.N.,India, for their constant support, guidance and encouragement.

5.CONCLUSION

This paper is a study and implementation of the analytical results for the bit error rate (BER) of M-ary Phase Shift Keying(MPSK) in a slow ,flat Rayleigh fading channel for an Alamouti multiple-input multiple-output (MIMO) system Maximal Ratio Combining scheme .The Mat lab simulation shows that as the number of receivers configurations in MIMO is increased, the Bit Error Rate(BER) of the system is decreased. The advantage of this selection scheme is that it does not require channel estimation to perform the selection. In order to implement conventional GSC, the gains of all the diversity channels must be estimated. However, no channel estimation is required to implement the GSTSoS selection. In the case of GSTSoS only $2L_s$ channel gains need to be estimated instead of $2L$ channel gains in the case of conventional GSC to implement the branch selection. In this system although there is additional circuitry needed to calculate the sum-of-squares for GSTSoS, it is only simple arithmetic circuitry that requires much simpler implementation compared to that of more complicated channel estimators.

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15th September 2011. Vol. 31 No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

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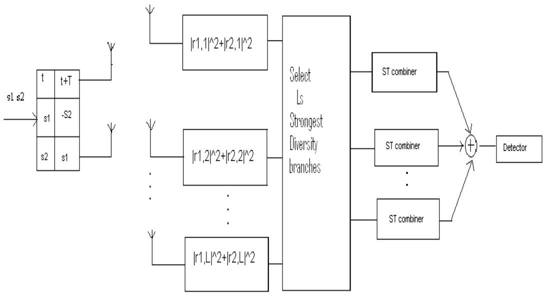

FIG: 1 THE MIMO SYSTEM USING AN ALAMOUTI SCHEME AND GSTSOS.

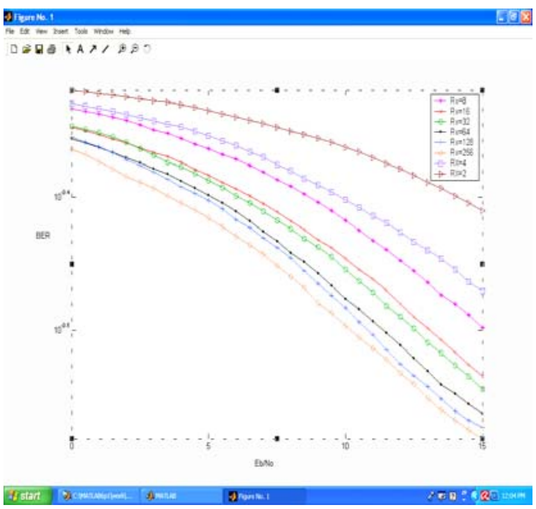

Figure no 2: Performance comparison of GSTSoS scheme by varying the no of receivers

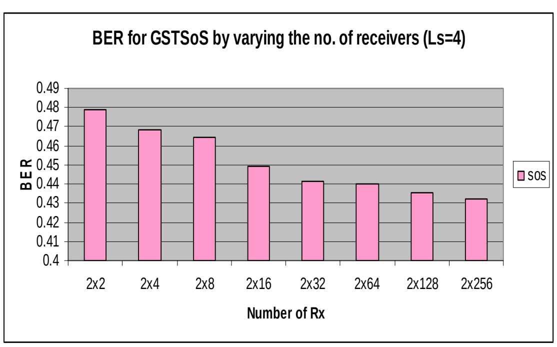

Figure no 3 Bargraph Performance comparison of GSTSoS scheme by varying the no of receiver

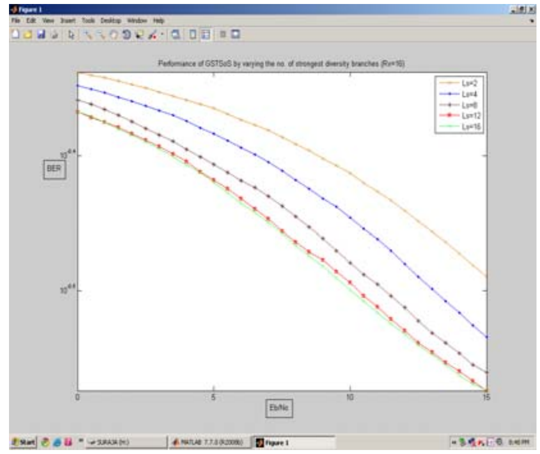

Figure No 4: Performance comparison of GSTSoS for various no. of strongest diversity branches(L_s)

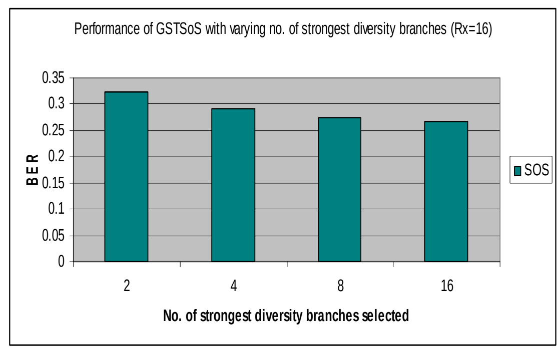

Figure No 5: Bar graph Performance comparison of GSTSoS for various no. of strongest diversity branches(L_s)