Performance Analysis of TCM OSTBC MIMO System in Different Fading Environment

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Abstract— Many wireless networks are become part of our daily life. The data rate and range in wireless devices are limited. To overcome this limitation one method is used named MIMO(Multiple input multiple output) is used. Multiple Input Multiple Output (MIMO) systems are wireless systems with multiple antenna elements at both ends of the link. MIMO systems have the ability to exploit, rather than combat, multipath propagation and promise a significant increase in capacity. MIMO communications use multiple antennas at both the transmitter and receiver to exploit the spatial domain for spatial multiplexing and/or spatial diversity. In contrast to spatial multiplexing the purpose of spatial diversity is to increase the diversity order of a MIMO link to mitigate fading by coding a signal across space and time, so that a receiver could receive the replicas of the signal and combine those received signals constructively to achieve a diversity gain. For improving the diversity gain with MIMO OSTBC(Orthogonal Space Time Block Code) . This MIMO OSTBC is used with conventional modulation scheme. Then this system is used using TCM(Trellis Coded Modulation). By using TCM OSTBC MIMO diversity can be achieved higher.
Keywords*-TCM ,OSTBC,TCM+OSTBC*

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I. INTRODUCTION

In wireless communication system , multipath propagation is a common phenomenon. In multipath propagation superposition of different components on each other and in result fluctuation in received signal is occurred which is called fading effect. Multipath propagation is done caused by stationary or movable obstacle. Fading effect reduces the quality of signal. In multipath propagation each signal has multiple ways , for reducing fading effect ensure that the signal does not follow the fading path but it follows the strong path which has very less fading effect. For realible communication multipath are intentionally created and this mechanism is called diversity.

There are many types of diversity introduced .Space diversity , time diversity and frequency diversity are basically three types. In space diversity multiple antennas are used , separated by some distance. In time diversity same signals are transmitted over different time intervals and this time is greater than the coherence time. In frequency diversity signals are transmitted over different frequency components , which is greater than coherence bandwidth.

In transmit diversity multiple antennas are used for receiver and transmit site. With the advent of space time coding (Alamouti's scheme) , it became possible to implement transmit diversity without knowledge of CSI.[6] .In this type of diversity transmitting power is divided among all antennas.

At receiver side, also multiple antennas are used and the purpose of this is decreasing the fading effect. At the receiver side all fading path components are received and replicas of the same signals are also received.

In this paper focus is given to fading, diversity, multiple input multiple output(MIMO), orthogonal space time block code (OSTBC) and trellis coded modulation(TCM).

II. ORTHOGONAL SPACE TIME BLOCK CODES

After applying the MIMO system in wireless communication then further increasing the diversity gain replicas of the same signals are transmitted through different transmitting antennas. By this method losing of information decreases. The diversity gain is defined as the number of independent receptions of the same signal. If in a MIMO system Nt number of transmitting antennas and Nr number of receiving antennas are used then maximum diversity gain is NtNr. The different replicas of same signals are encoded by space time block code and then this all symbols are send in different time.

We discuss OSTBC techniques with TCM modulation then compared for performance analysis of these techniques.

Alamouti's STBC used 2 transmit antenna and 1 receive antenna. By this scheme maximum diversity 2Nr can be achieved. The Alamouti scheme encoding operation is given by

$$T2=\begin{matrix} s1 & s2 \\ -s2* & s1 \end{matrix} \quad (1)$$

In this equation each column represents the transmitted symbol through each transmitting antenna. In this equation the first and second row represents the transmission at the first and second time instant respectively. For time t the symbol s1 and s2 are transmitted from antenna 1 and antenna 2 respectively.

The Alamouti's scheme used STBC with 2 transmitting antenna and 1 receiving antenna. The authors [2] have mathematical frame work of orthogonal codes that achieve full diversity. For the case of real orthogonal codes, it has been shown that a full rate code can be constructed[2]. For complex orthogonal codes it is unknown if full rate and full diversity codes exist for Nt>2.

III. Trellis Coded Modulation (TCM):

By OSTBC technique we can not get coding gain. Coding gain is the difference in S/N between a coded and uncoded system of the same information rate that produces the same error probability.

Concanated TCM + OSTBC shows in model 1. By the OSTBC we can get good full spatial diversity and by the TCM we can get coding gain.

In TCM for encode the data convolution code is used and for decoding Viterbi Algorithm is used. In this paper TCM , OSTBC and TCM + OSTBC all models and performance are shown in form of SNR v/s FER.

IV. System Model And Simulations

Simulations are done in Matlab simulink for TCM+OSTBC , TCM , OSTBC is transmitted in 2×1 systems using Rayleigh and Rician channel . it is explained in section IV. Bernoulli binary stream is applied in the TCM modulation block. SNR versus BER and SNR versus FER is plotted for both Rayleigh and Rician Channel and waveforms are shown in results. Comparative analysis of both channel is shown in table. Figure for all model is also shown in figure.

V. System Model Description :

The advantages of OSTBC is full diversity and TCM is coding gain , combining of both advantages TCM + OSTBC model is established.

The TCM + OSTBC ,TCM and OSTBC models are shown in figures :

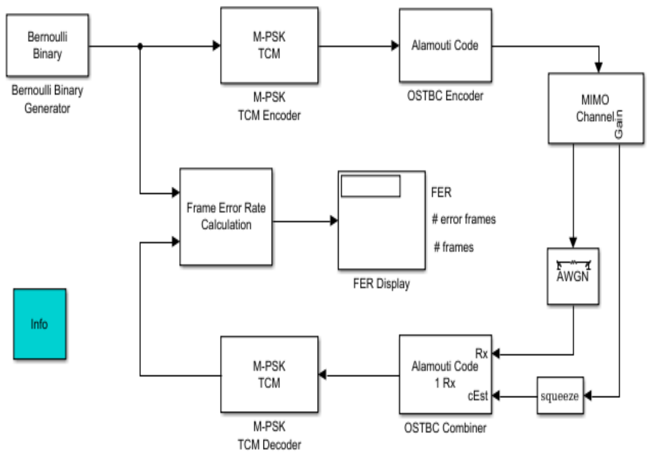

Fig 1: Concatenated TCM+OSTBC Model

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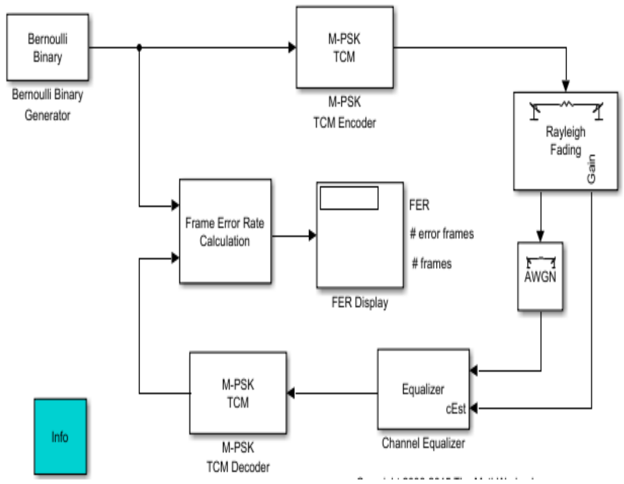

Fig 2 : TCM Model

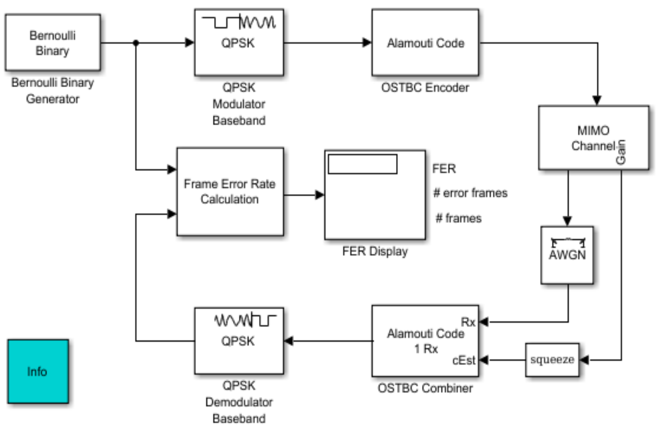

Fig 3: OSTBC Model

Bernoulli binary generator generates random data bits , then the M-PSK TCM modulates this bit stream and converts into PSK constellation which has unit energy . TCM modulator uses convolution coding for encoding the data so it gives

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better performance. OSTBC encoder encodes the data using Alamouti code , here it is used for 2 transmitting antenna .The output of this block is in form of matrix , in column of matrix denotes the transmitting the data over each antenna.

The mimo channel simulates the data , here 2×1 Rayleigh fading channel is used . it can also replaced by the Rician 2×1 channel. By the AWGN channel white Gaussian noise is added at the receiver side.

The OSTBC combiner combines the data from receiver antenna , it estimates into symbols and then fed those symbols to M-PSK decoder. M-PSK decoder decodes these data by Viterbi algorithm.

The frame error rate calculation compares the decoded bits and the original bit stream and the output is given to FER display. FER display shows three data frames , error frames and FER..

A. Figures and Tables

This section shows the simulation results. Figures 4 shows SNR versus BER plot for Rayleigh channel and figure 5 , 6 shows SNR versus FER plot for both Rayleigh and Rician channel for TCM+OSTBC , TCM and OSTBC.

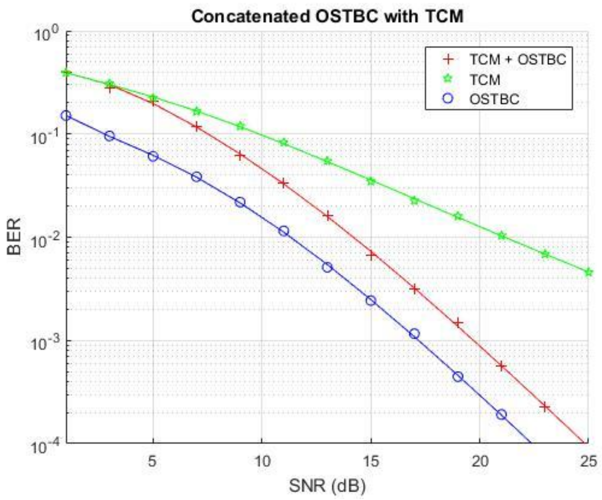

Fig .4: Simulation result for 2×1 TCM+OSTBC ,TCM ,OSTBC(Rayleigh Channel)

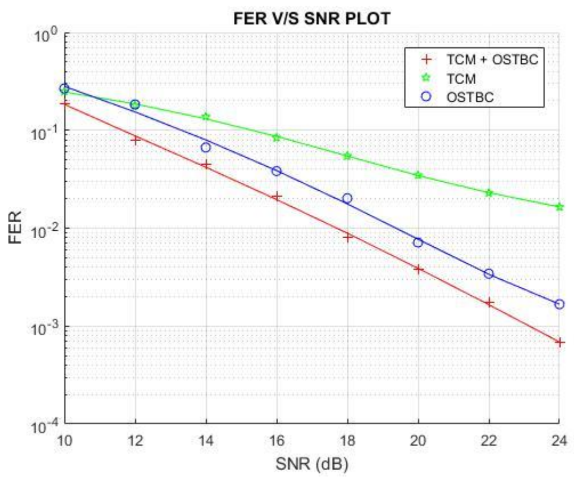

Fig. 5: Simulation result for 2×1 TCM+OSTBC , TCM and OSTBC(Rayleigh Channel)

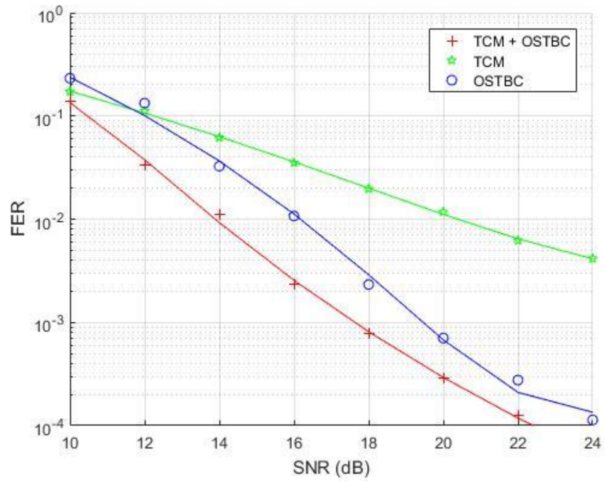

FIG. 6: SIMULATION RESULT FOR 2×1 TCM+OSTBC ,TCM,OSTBC (RICIAN CHANNEL)

Here all simulations are taken with 2×1 channel and modulation techniques are used TCM+OSTBC ,TCM and OSTBC with both Rayleigh fading channel and Rician fading channel.. Fig .5 and 6 shows that TCM+OSTBC gives better performance than TCM and OSTBC techniques in both Rayleigh and Rician channel .From both fig. :5 and 6 it is shown that TCM+OSTBC with Rician channel gives better performance than with Rayleigh fading.

	Frame Error Rate(FER)					
SNR (db)	TCM+OSTBC		TCM		OSTBC	
	Rayleigh	Rician	Rayleigh	Rician	Rayleigh	Rician
10	1.9E-1	1.3E-1	2.4E-1	1.6E-1	2.9E-1	2.1E-1
12	0.8E-1	3.1E-2	1.7E-1	1.1E-1	1.8E-1	1.3E-1
14	0.4E-1	1.1E-2	1.4E-1	6.1E-2	6.7E-2	3.1E-2
16	2.1E-2	2.2E-3	8.9E-2	3.2E-2	3.9E-2	0.1E-2
18	0.8E-2	7.8E-4	5.7E-2	0.2E-2	0.2E-2	2.1E-3
20	0.4E-2	2.9E-4	3.5E-2	0.1E-2	7.1E-3	0.7E-3
22	1.6E-3	1.4E-4	2.9E-2	0.6E-3	3.4E-3	2.7E-4
24	6.8E-4		1.7E-2	0.4E-3	1.8E-3	1.1E-4

Table 1: Comparative Analysis of TCM+OSTBC , TCM ,OSTBC(Rayleigh and Rician channel)

VI. CONCLUSION:

This paper provides basic overview of TCM+OSTBC , TCM and OSTBC for 2×1 MIMO channel for both Rayleigh and Rician fading channel. SNR versus FER plot are taken from

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MATLAB simulation tool. It is observed that from fig 5 and 6 , table 1 TCM+OSTBC with Rician fading channel gives better performance for 2×1 MIMO channel . The reason of this result is that in Rician fading channel line of sight(LOS) and non line of sight(NLOS) both are present.

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