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Performance of space-Time trellis coded with Hybrid modulation schemes OFDM system for antennas

Nikky (M.Tech Scholar), Sneha Jain (Asst.Prof),
Department of Electronics and Communication
*RITS Bhopal (M.P.)**

Abstract— *OFDM (Orthogonal Frequency Division Multiplexing) is a modulation technique widely used in modern communication systems. It offers high spectral efficiency and robustness against frequency-selective fading channels. ST-TCM is a technique that combines the benefits of spatial diversity provided by multiple antennas and the error correction capabilities of trellis coding.*
To estimate the performance of an OFDM system using ST-TCM, you can perform simulations in MATLAB or other simulation tools. The key steps involved in the performance estimation process are as
.In this dissertation, an encoder and Viterbi decoder are implemented to simulate the performance of STTCs in a second order diversity (two transmit and one receive antennas).Multimedia is effectively an infrastructure technology with widely different origins in computing, telecommunications, entertainment and publishing. New applications are emerging, not just in the wired environment, but also in the mobile one. At present, only low bit-rate data services are available to the mobile users. The radio environment is harsh, due to the many reflected waves and other effects. Using adaptive equalization techniques at the receiver could be
Index Terms—Space Time Trellis Codes, Fading, Diversity, *encoder and Viterbi decoder.*

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I. INTRODUCTION

The performance estimation of an Orthogonal Frequency Division Multiplexing (OFDM) system using Space-Time Trellis Coded Modulation (ST-TCM) is a significant research area in modern wireless communication systems. OFDM has gained widespread adoption in various wireless standards, such as Wi-Fi, 4G LTE, and 5G, due to its high spectral efficiency and robustness against multipath fading channels. ST-TCM is an advanced coding and modulation technique that combines spatial diversity and error correction coding to improve the reliability and data rate of wireless transmissions.than at the mobile stations (MSs).

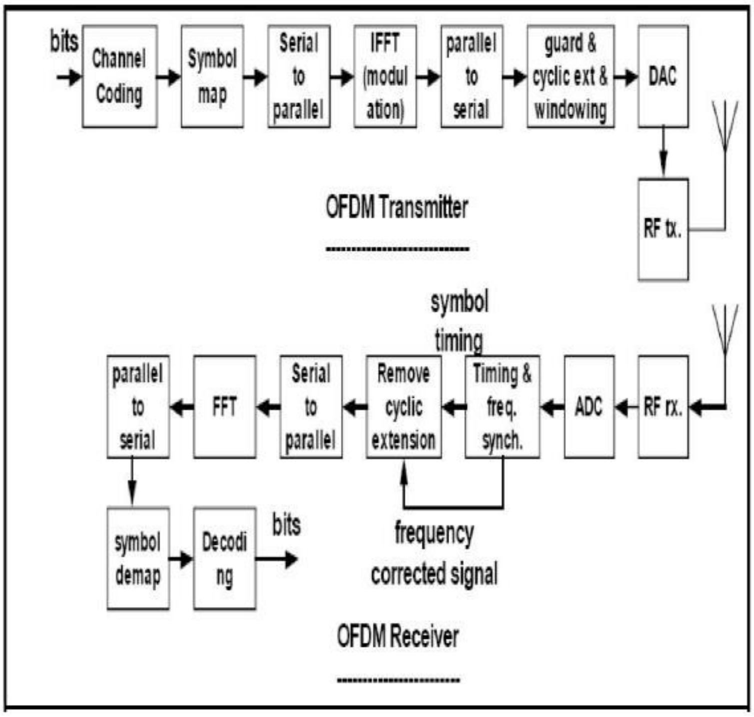
The introduction of ST-TCM in an OFDM system aims to exploit the benefits of multiple transmit antennas to combat fading and enhance the system's performance. By employing multiple antennas, the system can achieve spatial diversity, which helps mitigate the effects of fading and improves the system's reliability. The addition of trellis coding further enhances the error correction capabilities of the system, providing better resistance against channel impairments. diversity

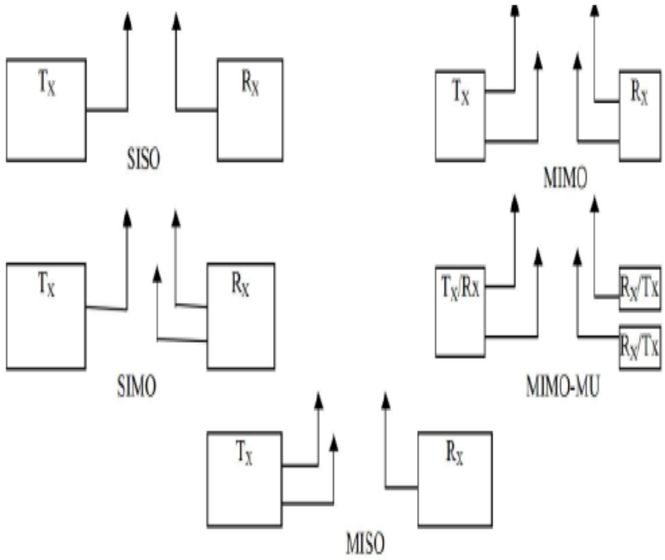
Orthogonal Frequency Division Multiplexing (OFDM)

- most famous interchanges systems in rapid correspondences in the most recent decade. Truth be told, it has been said by numerous industry pioneers that OFDM innovation is the eventual fate of remote correspondences.
- Orthogonal Frequency Division Multiplexing (OFDM) is a multicarrier transmission method, which separates the transfer speed into numerous carriers, everyone is adjusted by a low rate information stream.
- In term of numerous entrance procedure, OFDM is like FDMA in that the various client access is accomplished by subdividing the accessible data transfer capacity into different channels that are then assigned to clients.
- Some preparing is done on the source information, for example, coding for redressing errors, interleaving and mapping of bits onto signals. A sample of mapping utilized is QAM.

OFDM Receiver:

1. Reception and Downconversion: The received signal is downconverted to baseband and digitized.
2. Guard Interval Removal: The guard interval is removed from each OFDM symbol.
3. Parallel-to-Serial Conversion: The received samples are converted from the time-domain parallel format to the serial format.
4. Serial-to-Parallel Conversion: The serial samples are divided into parallel subcarriers.
5. Fast Fourier Transform (FFT): Each subcarrier undergoes an FFT operation to transform the signal from the time domain to the frequency domain.
6. Channel Estimation and Equalization: The channel response is estimated based on the known pilot symbols transmitted along with the data. Equalization techniques are employed to compensate for the effects of multipath fading and channel distortion.
7. Demodulation: The modulated symbols are demodulated using the inverse mapping scheme. The demodulation process depends on the specific modulation scheme used.
8. Trellis Decoding: The demodulated symbols undergo trellis decoding, which reverses the encoding process and corrects errors introduced during transmission.
9. Data Recovery: The decoded symbols are converted back into binary data to recover the the original information.



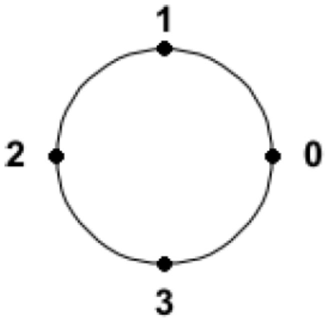


Code design

- Diversity advantage (DA) is the exponent in the error probability bound.
- In order to improve the performance of ST codes, the diversity advantage must be maximised by maximising the rank of the difference matrix.
- 1st Design criteria: the minimum of the ranks of all possible matrices D = C-E must be maximised. To achieve the full rank n all matrices D must have full rank.
- Coding gain (CG) is the term independent of SNR in the upper error bound.
- It is the product of eigenvalues of the difference matrix or of Euclidean distances.
- 2nd Design criteria: in order to maximize the coding gain, the minimum of the
- products of Euclidean distance (or equivalently the eigenvalues) taken over all pairs of codes C and E must be maximized.

Code Construction

- STTCs can be represented in a graphical manner and can be analyzed in their trellis structure or in the form of their generator matrix, G. For example, assume the 4PSK signal constellation shown in Figure 1, where the signal points are denoted as 0, 1, 2, and 3.



4PSK Signal Constellation

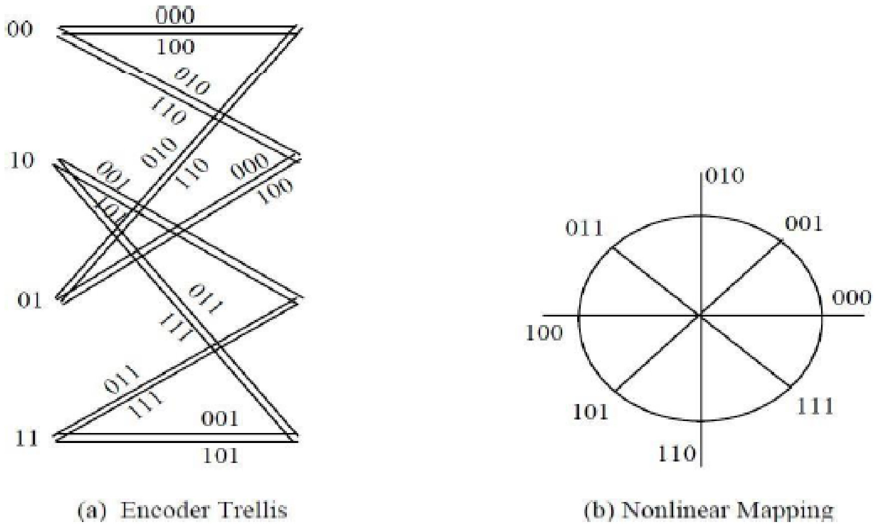


Fig.1 4-State TCM Code for 8-PSK

- The input signal may possess any value from their signal constellation (in this case 0, 1, 2, or 3); they are given in their trellis diagram on the transition branches. Generally, for each state,
- the branch of first transition towards state 0 results from input 0, the second transition branch towards state 1 results from input 1, and so on. The output basically depends on the input and on the current state The states are mentioned on the right. The labels on the left of the trellis denote the possible outputs from state.
- The leftmost output is considered to be the output for the first branch for given particular state, and the second one is assumed to be the output for second trellis branch for the same state, and so on.
- These considerations were verified to be correct and can be manually traced through the encoder structure.
- It was justified in that the STTC provides a gain of diversity of 2 (considering one receiving antenna), and has at least determinant of 2.

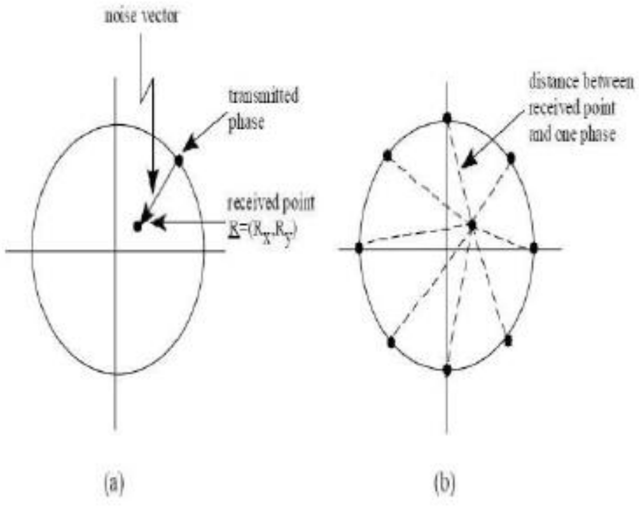


Fig.2.Effects of noise on 8 PSK and Euclidean Distance

1. Branches diverging from the same state must have the largest distance.
2. Branches merging into the same state must have the largest distance.
3. Codes should be designed to maximize the length of the shortest error event path for fading channel (equivalent to maximizing diversity).
4. By satisfying the above two criterion, coding gain can be increased.

SIMULATIONRESULT

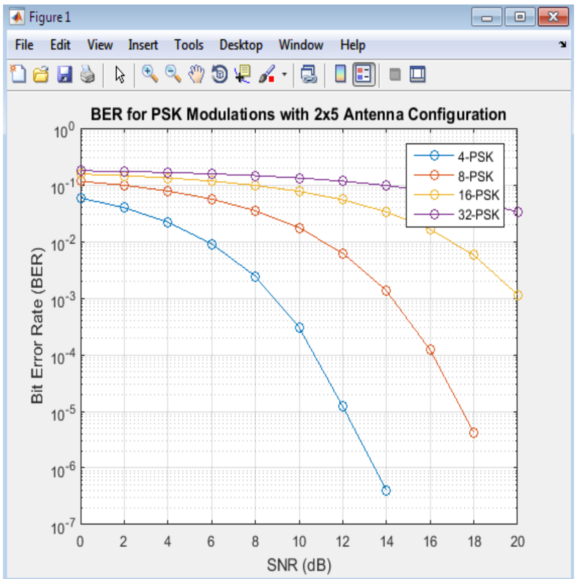


Fig. 3 B.E.R STTC 4PSK, 8PSK,16PSK, 32PSK Modulation with OFDM using 2x5 Antenna

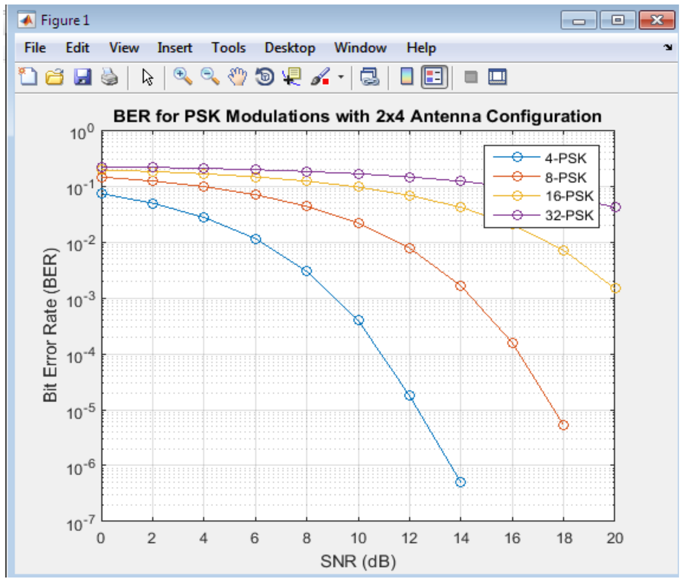


Fig .4 B.E.R Graph of STTC 4PSK, 8PSK, 16PSK, 32PSK Modulation with OFDM using 2x4 Antenna

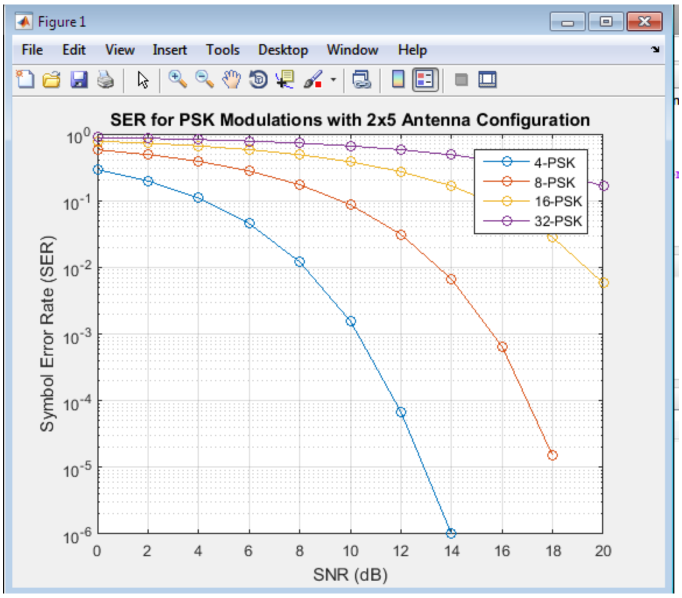
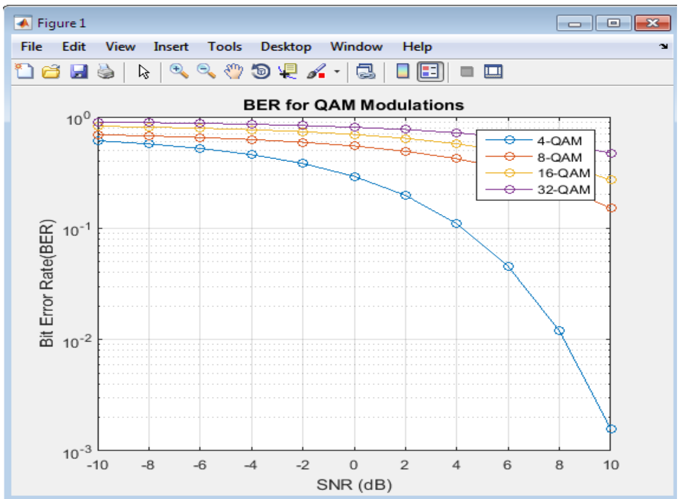


Fig .5 S.E.R. Graph of STTC Modulation State with OFDM using 2x5Antenna



B.E.R.,. Graph of STTC QAM Modulation with OFDM using 2x2 Antenna

The above diagram show the BER, SER Graph of STTC 4/8/16/32QAM States Modulationwith OFDMusing 2x4,Antenna,2x5Antenna ,2x5 Antenna where we are getting the satisfactory result as per ourpaper.
Simulations are carried out using trellis code with 4 PSK, 8 PSK and 16 PSK ,32 PSK modulation schemes with 4/8/16/32 states and then an OFDM system is considered to transmit the data bits thus we implemented the trellis coded modulation with the OFDM system at the transmitting side, AWGN noise channel is considered for transmitting data.
At the receiving side, viterbi decoder is used to decode the data. Simulations are carried out by considering 2x2, 2x4 and 2x5 antennas. It is observed that results are better in case of 2x5 antennas

II. CONCLUSIONS

- Modulation Scheme Comparison: Conduct a thorough performance comparison of different modulation schemes, such as BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM, and higher-order constellations. Evaluate the trade-off between spectral efficiency and error rate performance for each scheme.
- Adaptive Modulation and Coding: Implement adaptive modulation and coding techniques that dynamically select the most suitable modulation scheme based on channel conditions. This approach can optimize system performance by utilizing higher-order constellations when the channel quality is good and switching to lower-order constellations under poor channel conditions.

Advanced Coding Techniques: Explore advanced coding schemes, such as LDPC (Low-Density Parity-Check) codes, Turbo codes, or Polar codes, to improve error correction capabilities and enhance the system's reliability and perform.

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