Modeling And Analysis Of Modulation Schemes On Antenna Space Blocks Time Code

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Abstract: Wireless networks and their variant examples are becoming very critical to human technological developments. Meanwhile, the data and ranges of the wireless devices are limited. Academic and researchers have done a lot of works in finding solutions to overcoming the challenge. Adopting Multiple-Input Multiple-Output (MIMO) and its links is a good solution. This paper models and analyses few of the actions that can be performed on multiple antenna by using MIMO systems, which include space-time coding or diversity coding, spatial multiplexing, and multi-layer beam-forming. In the simulation aspect, Simulink in MATLAB is used to simulate one receive and two transmit antennas. Results for computing Bit error rate for BSK modulation using Alamouti space block time coding (SBTC) in a Rayleigh channel is shown and analysed. The constellation diagram for the various modulation techniques including BPSK, QAM 64 and QPSK 16 modulations is also reported and discussed. The result of the simulation shows that bit error rate is reduced with multiple antennas during transmission over the use of single antenna.

Index Terms: Constellation, MIMO, Modulation, Simulation, Wireless networks.

1 INTRODUCTION

There is a trend of demand increase for the use of high spectral efficiency which alongside data rate are the pivot in wireless communication as a continued driving force in technology evolution. Among others, implementing the Multiple-Input / Multiple Output (MIMO) systems and smart antenna approach in wireless networks with involve high impact effect on cost reduction for network building, service quality optimization, and transparent realization in the operation of the multi-technology wireless systems. This involves the application of multiple antennas in multiple communication over the network, as an incentive for range and speed increase. MIMO technology was invented recently to act for increase in the performance and throughput of the wireless communication networks [1]. There has been tremendous research breakthrough in many fields of application of the technology, including wireless propagation, information theory and signal processing. MIMO technology is now an established tool in the present and future communication systems and standards. The study of "realization of different diversity technique for MIMO based mobile ad hoc network using Space block time codes" in [2], [3], [4]. Space block time codes (SBTC) remain vital diversity technique to display superior performance quality of MIMO enabled mobile ad-hoc system compared with single antenna system. The better performance is typically demonstrated in high Signal to Noise Ratio (SNR) of the system. A study by [5], [6] was conducted on "Performance Comparison of MIMO Systems over AWGN and Rician Channels with Zero Forcing Receivers". This analysis in the study aimed at establishing the effect of the system on the (BER) Bit Error Rate. The "Performance Evaluation of Multiple Antenna Systems with Diversity Techniques Using Ber Analysis" has been investigated in [7], [8]. The study has examined multiple-antenna efficiency in the mitigation of signal interference. Signal degradation is a result of multipath propagation in wireless communication. There was an introduction of Version 7.0 of MATLAB Toolbox for performance analysis of BER for Raleigh channel environment for diverse antenna systems, especially the single input single output (SISO). The model also incorporated at the receiver, a Zero Forcing Equalizer. In mitigating the signal fading problem and poor signal reception, [10] explored the use of MIMO antenna system and a space diversity method. Space-diversity approach has been discussed in literatures as a very good tool to solve signal fading problems in radio broadcasting. It is specifically domiciled for broadcasting with transmitting stations and the studio within different locations, but linked up by using multiple antennas at the transmitter and receiver ends. Inverse proportional relationship was established between signal strength and distance, as a confirmation of the attenuation square law [9]. A geometry-based model has been proposed in [10] for the effects of propagation which are necessary in MIMO performance analysis. Single scattering in the MS and BS, double scattering, wave-guiding, roof edges diffraction, and far clusters scattering were observed in the work. The parameter details for the model definition, the macro and microcellular environment were analysed and presented. It was a new cooperative communication class approach which allows single mobile antennas in any multi user environment sharing their antenna, create virtual multiple transmitter, and enable the gaining of the transmit diversity. The overview in the development of the burgeoning field, with the effective space time code using a large available capacity has been reported [11], [12], [13], [14]. It considered the case of partial and not perfect transmission, information on the channel, with how to enhance the predetermined codes. In optimizing the linear transformation for scheduled codes, a frequency and non-selective fading path has its working criterion set [15], [16]. The optimization process resulted in a convex to be solved efficiently with a standard methods, being independently and specifically developed for the coefficients of fading channels. The conventional beam forming benefits, and that of the orthogonal space block time coding wee combined in the proposed scheme. In the simulation analysis of the narrow band system consisting of one receive and multiple transmit system, there was significant gains compared with the conventional approaches [17]. There was a documentation of a MIMO OFDM wireless communication, field and lab test carried out in San Jose, California [18]. The experiment observed the performance analysis for the MIMO

system. The result indicated an increase in size, reliability and coverage within the system performance. A space-time code for the orthogonal frequency division multiplexing system (OFDM) was reported in [19], [20], [21] for application in selective frequency fading channels. The pairwise error and probability analysis indicated that STC-OFDM systems gives the diversity order in the product for a number of receivers, transmitter antennas, and the frequency selectivity. Also, the two most important design principle for STC in OFDM systems are the ideal interleaving coefficients and efficient length. Another work reported by [22] is simple two-branch transmit diversity scheme. Meanwhile, an adaptive diversity scheme using space time-transmit and simple feedback has been reported in [23] as the future of wireless communication research work in other to optimize and interrelate the benefits of the previous works and overcome as many as possible of the limitations [24, [25], [26]. This paper propose to model and simulate the space block time code for the different modulation schemes in other to show the benefits of using multiple antenna for the transmitting end and the receiving end.

2 METHODOLOGY

2.1 Problem Formulation

This paper performs the modulation scheme analysis using SBTC (Space Block Time Code). It also shows the results for computing the Bit error rate (BER) for different modulation Binary phase shift keying (BPSK), binary shift keying (BSK), Quadrature phase shift keying (QPSK) 16, and Quadrature amplitude modulation (QAM) 64 baseband. This study aims at performing analysis of different modulation scheme including BPSK, 64 QAM and QPSK 16 schemes, showing the best schemes in signal transmission, and also showing the different constellation diagrams for the different modulation techniques.

2.2 Design and Simulation

The focus of the SBTC research is on the improvement of the system performance through the employing of extra antenna transmits. In design effect, SBTC sums up to find the matrices of transmit transmits matrices that which ensures optimality criteria. SBTC achieves a transmit diversity gain and can work with one receive antenna, often with simple processing and combining techniques. The block diagram showing the outline of the system design is as shown in Fig. 1, while the various forms of MIMO system is as shown in Fig. 2. Other coding methods are also available, but this study has selected SBTC Simulations were carried out in MATLAB to show the various modulations technique as shown in Fig 3, 4 and 5. For BPSK the simulation was carried out in Simulink using three transmitter and two receiver as the OSBTC combiner, Binary Bernoulli modulation was used as well as BPSK modulation band.

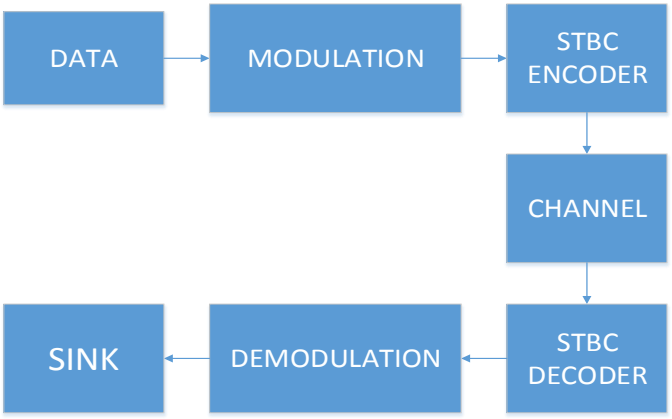

Fig. 1 System Block Diagram

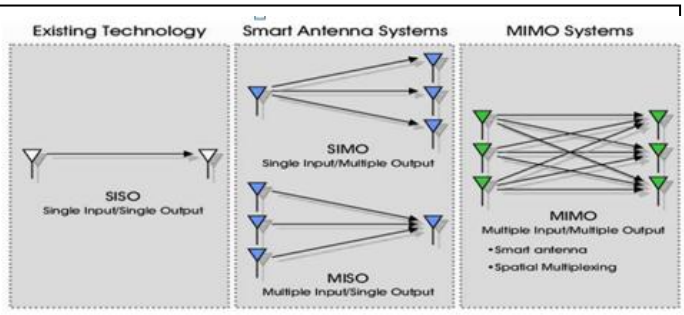

Fig. 2 Forms of MIMO Antenna Systems

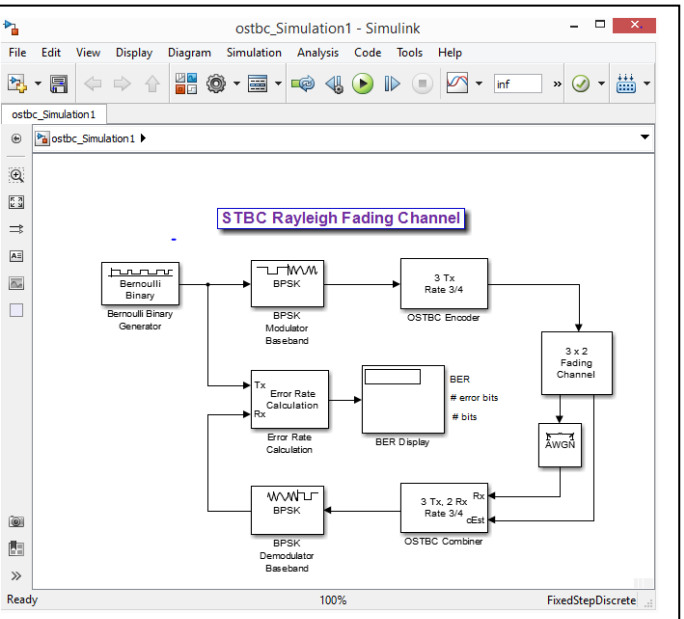

Fig.3 Simulation of BPSK Modulator Baseband

The E_b/N_o (dB) was varied from 0 to 20. This was done in other to determine the various variations of signal and find out the signal with the lowest frequency bandgap. The E_b/N_o (dB) (dB) is varied by double clicking on the All White Gaussian Noise (AWGN). This will display a block shown below where the E_b/N_o (dB) (dB) is varied and run

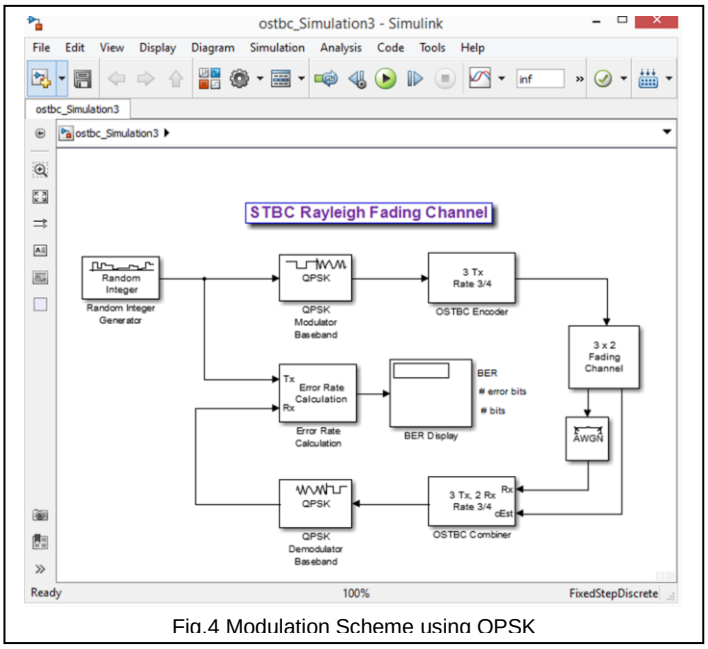

Fig.4 Modulation Scheme using QPSK

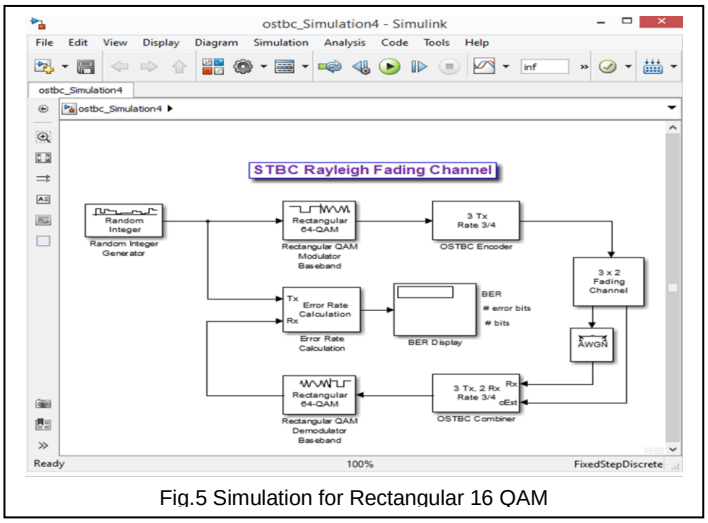

Fig.5 Simulation for Rectangular 16 QAM

3 RESULTS AND ANALYSIS

The result of the simulation for the system performance with ne receive antenna and two transmit antenna is presented. The system performance being analysed over SNR values from 0dB and 20dB is being reported. It was observed that QPSK and BPSK values are similar at constant value for all other variables. When the transmitted bits/symbol increased, there was degrading of the performance for all the various code blocks. Also at high SNR and different modulation, by making Nt =1 constant, varying Nr between 0 and 20, BER curve showed relative variation as shown in Fig 6. Another interesting observation was that when keeping Nr =1 and SNR high, 64-QAM performed better than 16-QAM but reversed at Nr = 1 and low SNR. The relationship among SNR and BER in a wireless link is as shown in Table 1.

TABLE 1 Relationship of Signal Noise Ratio (SNR) To Bit Error Rate (Ber) In a Wireless Link

Signal noise ratio (SNR)	Bit error rate (BER)
0	0.01773
1	0.01191
2	0.008589
3	0.003426
4	0.00178
5	0.006782
6	0.0003371
7	0.0001581
8	$6.7e^{-05}$
9	$62.1e^{-06}$
10	$9e^{-06}$
11	$2.1e^{-05}$
12	$1e^{-06}$
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0

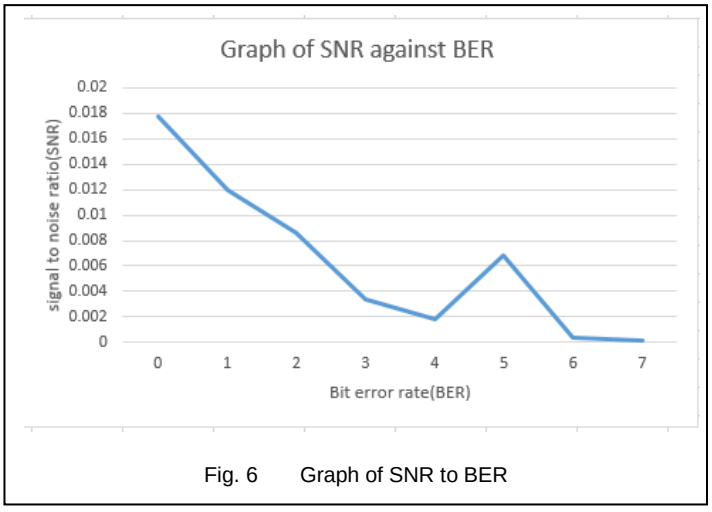

Fig. 6 Graph of SNR to BER

The various curves for the Alamouti SBTC is as shown in Fig. 7. The black curve shows an ideal curve for transmission using 2 receive and 1 transmit antenna which showed as the best for transmission. The red curve shows the simulated curve for 1 receive and 2 transmit antenna, based on the Alamouti scheme. The blue curve shows the transmission using 1 receive and 1 transmit antenna. This shows that using multiple antennas during transmission reduces code error rate and improves the strength of the signals.

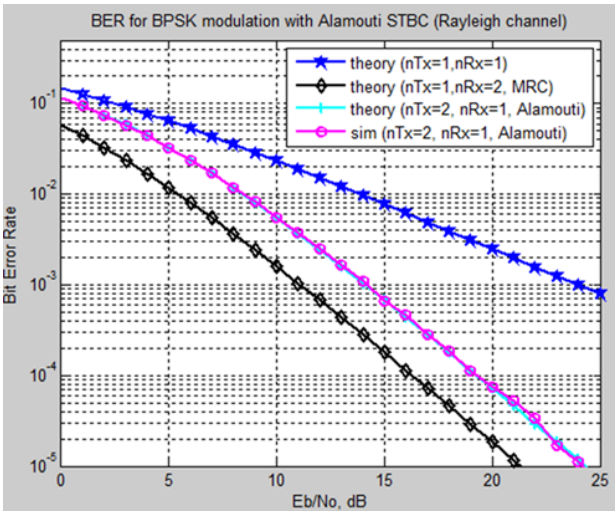

Fig. 7 Alamouti SBTC (Rayleigh channel) enabled Bit error rate (BER) modulation

3.1 Constellation view Of OSBTC Simulation BPSK Modulator Baseband

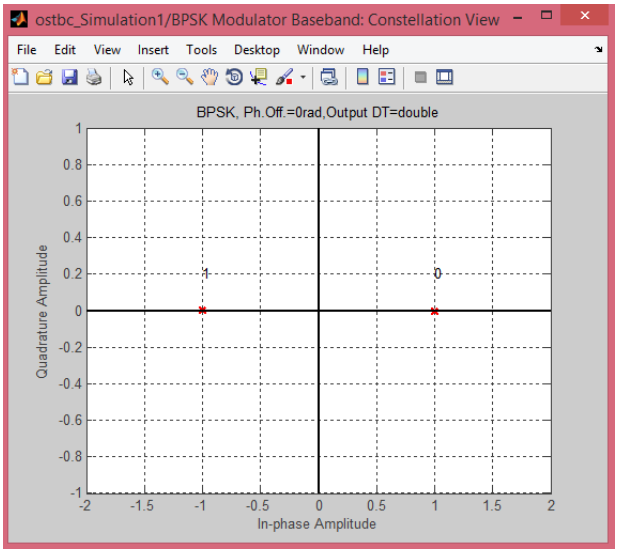

Fig. 8 Constellation view of OSBTC simulation BPSK modulator baseband

As shown in Fig 8, the signals are far apart so the interference and distortion is very low. BPSKs is the best modulation scheme having taken the highest noise or distortion level to cause the attainment of incorrect decision by the demodulator.

3.2 Constellation View: QPSK Modulator Baseband

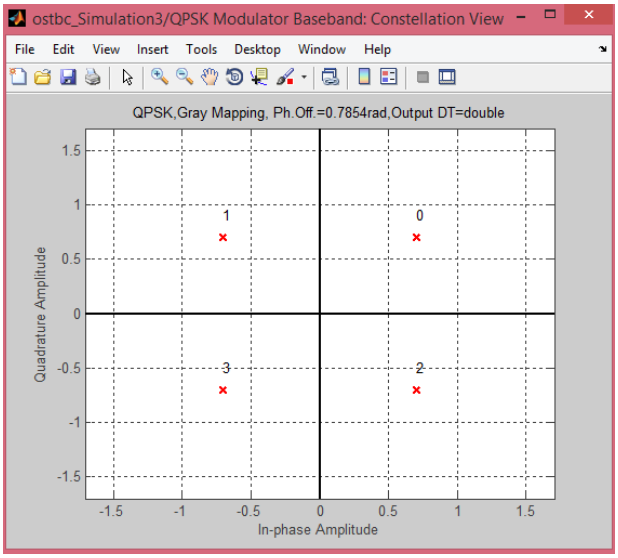

Fig. 9 Constellation view: OSTB simulation/BPSK modulator baseband.

In Fig. 9, there are four signals but the interference and distortion of signal is minimal. The distortion is high when compared to the constellation diagram of BPSK modulator

3.3 Constellation view of the Rectangular baseband of the QAM Modulator

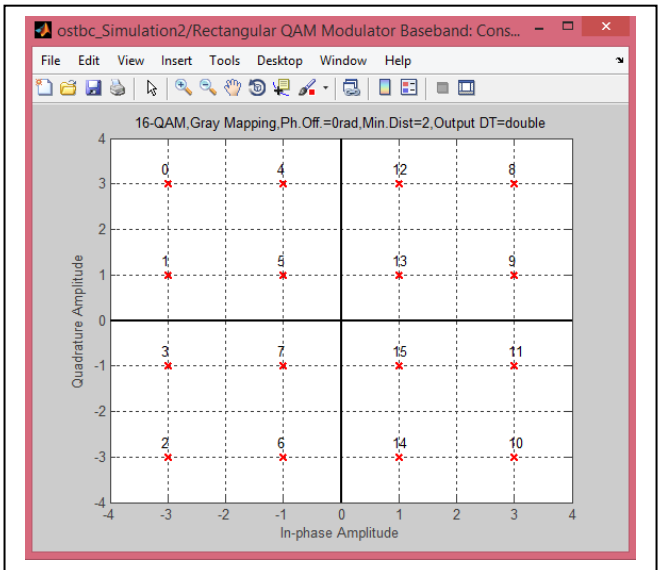

Fig. 10 Constellation view: OSBTC simulation/ Rectangular Modulator baseband.

As shown in Fig 10, there are 16 signals. There will be distortion and interference signal when compared to the constellation diagram of QPSK modulator baseband.

3.4 Constellation View: OSBTC Simulation Rectangular of the baseband for 64 QAM Modulator

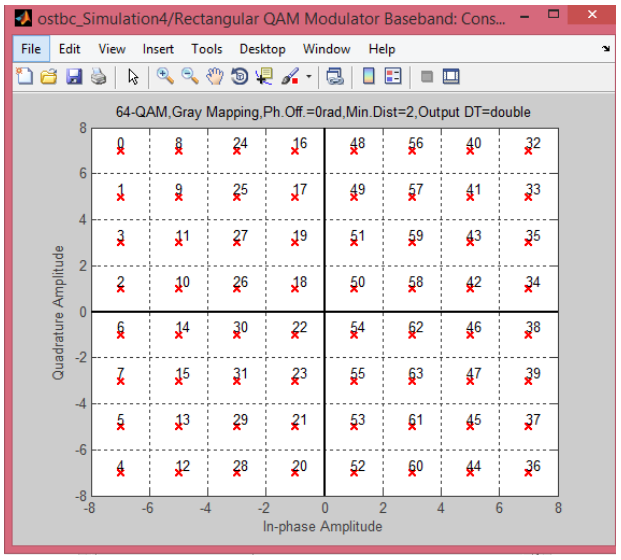

Fig. 11 Constellation view of rectangular 64 QAM modulator.

The signals have the highest signal interference and distortion as the signals are closed to one another. This is the baseband with the highest distortion

4 Conclusion

The basic multiple-inputs multiple-outputs MIMO system overview and introduction to Space- Block Time Coding technique has been presented in this paper. Also presented in the paper are the several performance analysis of different modulation scheme on SBTC with results for computing the Bit error ratio (BER) for BSK Rayleigh channel modulation using the Alamouti SBTC for a receive and two transmit antenna. The simulation of the Alamouti for BPSK Rayleigh channel modulation was carried out and the result shown. From the results and analysis, it is clear that employing MIMO is more efficient than single antennas as the bit error rate is greatly minimized when using the multiple antennas at both end of the transmitter and receiver.

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