Wireless Communication System Performance Estimation with MIMO STBC Technology and Linear Filtering

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Abstract - The wireless communication system is a largely used in the present era of communication. The enhancements in the technology to make more reliable end to end connectivity and transfer of information lots of research being executed. The multiple input multiple output (MIMO) technique significantly improve the quality of communication. In this paper a new approach is proposed to make communication system more better. The system is MIMO based on space time block coding (STBC). Here the system is evaluated with 2-PSK, 4-PSK and 8-PSK Modulation. To make bit error rate i.e. figure of merit minimized additionally moving average filtering is used, and it can be seen that using 2-PSK BER is better than higher PSK .

Keywords - BER, MIMO, PSK, MAF and STBC.

I. INTRODUCTION

The field of wireless communication systems and networks has experienced explosive growth and wireless communications has become an important part of everyday live. Further, the rapidly increasing number of wireless communication subscribers, the growth of the internet and the quickly increasing use of wireless devices suggest that wireless internet multimedia access will rise rapidly over the next few years. The demand and purchase of wireless telephones is predicted to soon exceed the purchase and use of traditional wired telephones. In some developing countries like China, India and also in many countries in Africa, the infrastructure of wireless communication systems is more sophisticated in comparison to wired communication systems. This comes from the fact that new telephone cables have to be laid at great expense for wired communication systems, which is not necessary for mobile systems. As mentioned above, the market for mobile devices has dramatically increased and continued growth is predicted. Along with this rapid growth comes the customer demand for more and better applications, improved performance, and increased data rates. They want the ability to communicate on their own terms; to get connected and stay connected in order to send and receive information in any form, let it be voice, text, image, or video. As an example, customers are using mobile telephone applications like Multimedia Message Services (MMS), an extension of text messaging (SMS), that adds pictures and sound elements. In short, they want the ability to rely on a wireless device to improve and add diversity to traditional ways and forms of communication by connecting them to the mobile services they want and need anytime and anywhere.

All these improvements must be accomplished under a considerable number of constraints. Wireless channels are by its nature random and unpredictable and results therefore in uncontrolled refraction, scattering, shadowing and attenuation of the transmitted signal. Due to the constructive and destructive superposition of different signal waves at the receiver, it may be infeasible to detect the transmit signal correctly. These effects can be statistically modeled as a multiplicative random variable and are referred to as fading. The spectrum or bandwidth available to the service provider is often limited and expensive. For example, at the auction of the licenses for the new frequencies and radio spectrum of the third generation (3G) mobile technology UMTS (Universal Mobile Telecommunications System) in Germany, the wireless communication systems operators paid about 50 billion euro. Furthermore, the power requirements are such that devices should use as little power as possible to conserve battery life and keep the products small and cheap.

This should also apply to next generation handset models of which many have built-in cameras. Furthermore, most models will be multi-band and multi-mode, allowing users to switch seamlessly between different services in various mobile technologies like UMTS, GPRS (General Packet Radio Service), and GSM (Global System for Mobile Communications) in different frequency bands. Designers of wireless systems therefore face a two-part challenge of increasing data rates and improving performance while incurring little or no increase in bandwidth or power, and costs. This thesis provides an analysis of new transmission schemes referred to as space time codes in order to guarantee reliable transmission and improved performance in mobile communication systems. The first part is devoted to uncoded (regarding channel coding) space-time codes or space-time transmission schemes and their performance with respect to data rate and error probability with different optimal and suboptimal detection schemes. In the second part the space-time transmission schemes are combined with conventional channel codes like convolutional or block codes and their performance is analyzed with respect to iterative detection and decoding using information theoretic techniques.

MIMO:

In this section, we describe briefly the performance of single-user, point-to-point wireless links by employing MIMO technology. In multi-antenna systems with nT transmit and nR receive antennas, the data is sent simultaneously and synchronously from the transmit antennas. The signal received at each antenna is therefore a superposition of the nT transmitted signals corrupted by additive noise and multiplicative fading. From the traditional point of view, the interference the received signals experience from each other would be a limiting factor for reliable communication. From an information-theoretic point of view, one may view the system under consideration as providing not one, but nT £ nR potential communication links between the transmitter and receiver, corresponding to each distinct transmit/receive antenna pairing. The improvements in comparison to single-input single-output (SISO) systems is not only the diversity provided by MIMO over fading channels. Information theoretic results have demonstrated that the ability of a system to support high link quality and higher data rates in the presence of Rayleigh fading improves significantly with the use of multiple transmit and receive antennas as described in the following subsections.

II. SPACE-TIME CODES

Space-time code (STC) is a method usually employed into wireless communication systems to improve the reliability of data transmission using multiple antennas. STCs rely on transmitting multiple, redundant copies of a data stream to the receiver in the hope that at least some of them will survive the physical path between transmission and reception in a good state to allow reliable decoding. Space time codes could be divided into three types. First, space–time trellis codes (STTCs)[6] distribute a Trellis code over multiple antennas and multiple time-slots. STTCs are always used to provide both coding gain and diversity gain. Space-time trellis code, proposed by Tarokh, is a scheme where symbols are encoded according to the antennas through which they are simultaneously transmitted and decoded using maximum likelihood detection.

Trellis coding is a very effective scheme that provides a considerable performance gain, as it combines the benefits of forward error correction (FEC) coding and diversity transmission. However, the scheme requires a good trade-off between constellation size, data rate, diversity advantage, and Trellis complexity. The second type of STCs is space-time turbo codes (STTuC) a combination of space-time coding and turbo coding [2]. They are originally introduced as binary error-correcting codes built from the parallel concatenation of two recursive systematic convolution codes exploiting a sub-optimal but very powerful iterative decoding algorithm, which is called turbo decoding algorithm. The turbo principle has these days been successfully applied in many detection and decoding problems such as serial concatenation, equalization, coded modulation, multi-user detection, joint interference suppression and decoding.

Space-time Block Codes:

Space-time block codes (STBC) are a generalized version of Alamouti scheme [8]. These schemes have the same key features. Therefore, these codes are orthogonal and can achieve full transmit diversity specified by the number of transmit antennas. In another word, space-time block codes are a complex version of Alamouti's space-time code in [7], where the encoding and decoding schemes are the same as there in the Alamouti space-time code in both the transmitter and receiver sides.

The data are constructed as a matrix which has its rows equal to the number of the transmit antennas and its columns equal to the number of the time slots required to transmit the data. At the receiver side, when signals are received, they are first combined and then sent to the maximum likelihood detector where the decision rules are applied. Space-time block codes were designed to achieve the maximum diversity order for the given number of transmit and receive antennas subject to the constraint of having a simple linear decoding algorithm. This has made space-time block codes a very poplar scheme and most widely used. Space-time block codes and indeed many other space-time techniques including STTCs are designed for coherent detection where channel estimation is necessary.

There is a substantial literature addressing the channel estimation issue for multiple-input multiple-output (MIMO) systems, ranging from standard training based techniques that rely on pilot symbols [3] in the data stream to blind which does not require pilot sequences and semi-blind estimation where observations corresponding to data and pilot are used jointly. Other authors have considered non-coherent detection schemes based on differential encoding which do not require channel state information (CSI) [2] [8]. Although these methods avoid the need for channel estimation, they often suffer from problems such as error propagation. Training-based methods seem to give very good results on the performance of channel estimation at the receiver. Pure training-based schemes can be considered as an advantage when an accurate and reliable MIMO channel needs to be obtained. However, this could also be a disadvantage when bandwidth efficiency is required. This is because pure training-based schemes reduce the bandwidth efficiency considerably due to the use of a long training sequence which is necessarily needed in order to obtain a reliable MIMO channel estimate.

III. PROPOSED METHODOLOGY

The advancement in the technology is a continuous process of research on small factors to improve the performance of the system. The concept of making wireless MIMO channel based system with end to end reliability of information is achievable using the space time coding techniques in addition with the efficient modulation techniques, that helps to shield the signals from unwanted noise attacks and interferences.

In the below figure the same system is equipped with the Almouti STBC coding and PSK Modulation technique, and applying moving average filter at the receiver side to reduce the effect of distortions and interferences.

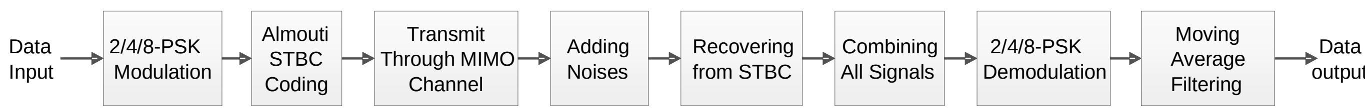

Fig. 3.1 Block diagram of proposed system

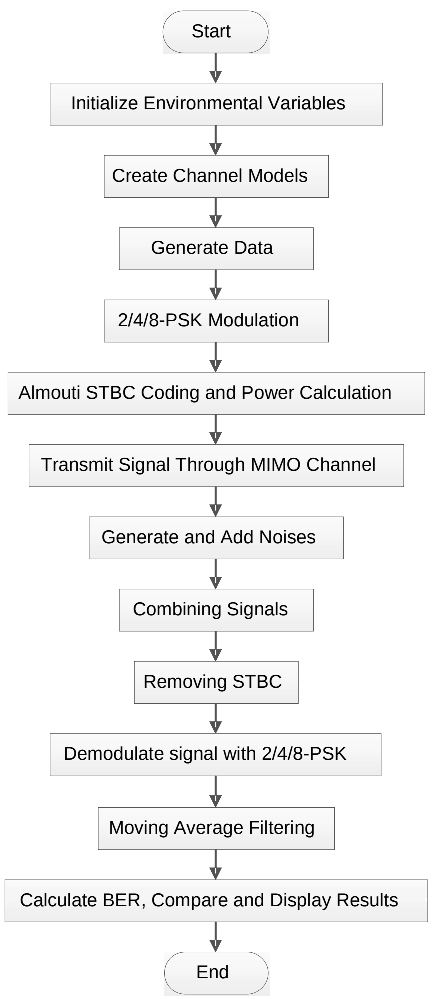

Fig. 3.2 Flow chart of implemented simulation model of proposed system

The above mentioned flow chart is the step by step flow of computer algorithm implemented on simulation tool. The steps are as follows:

a. *Start of simulation*
b. *Create an simulation environment using variables*
c. *Create Channel Model*
d. *Generate data to transfer over communication system*
e. *Modulate with 2/4/8-PSK modulation scheme*
f. *Apply Alamouti STBC Coding and power calculations*
g. *Transmit signal through MIMO channel*
h. *Generate Noises and add with signal*
i. *Combine Received signals*
j. *Remove STBC coding*
k. *Demodulate signal with 2/4/8-PSK*
l. *Apply Moving Average Filtering*
m. *Calculate BER and Compare and Display results*
n. *End of Simulation*

The above mentioned algorithm gives the results by which the outcomes of the proposed methodology

IV. SIMULATION RESULTS

The proposed system mentioned in the previous section simulated and the outcomes are displayed in terms of bit error rate (BER) vs signals to noise ratio (SNR). In the below figures all the simulation results analyzed with 2-PSK, 4-PSK and 8-PSK modulation is displayed.

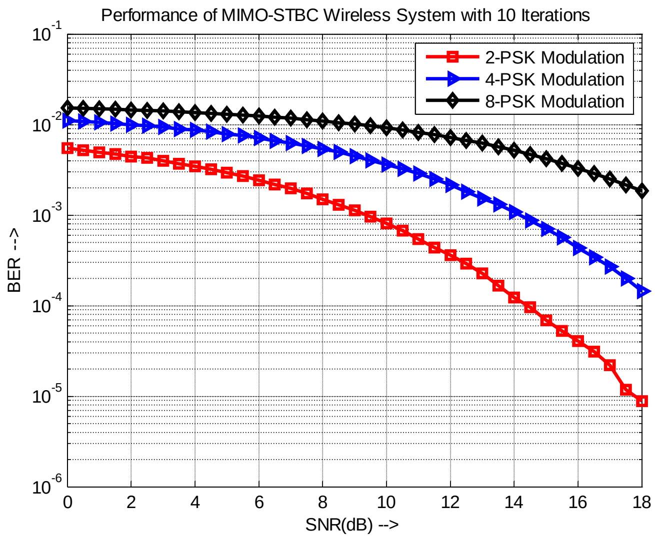

Fig. 4.1 BER performance of the MIMO system with 2, 4 and 8-PSK modulation and 10 iterations with Moving Average Filtering

In Fig. 4.1 the Almouti STBC coding based system and modulation scheme is Phase Shift Keying. The Phase Shift Keying modulation scheme is simulated with different variations e.g. 2-PSK, 4-PSK and 8-PSK. The whole simulation repeated for 10 times. The simulation results shows that BER performance is good for 2-PSK with moving average filter.

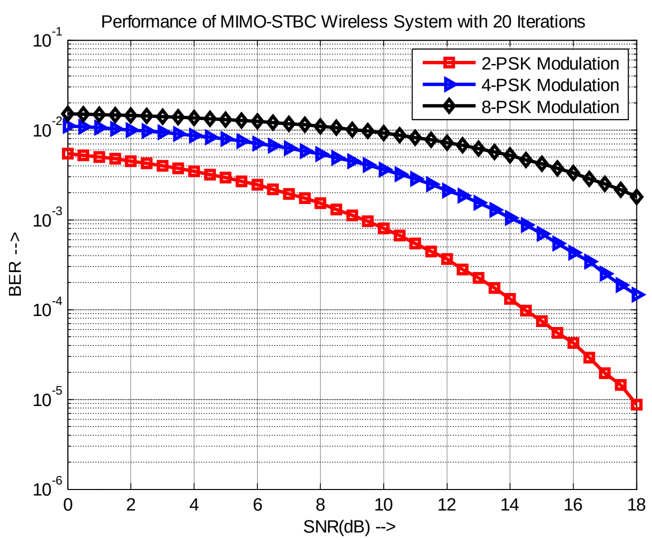

Fig. 4.2 BER performance of the MIMO system with 2, 4 and 8-PSK modulation and 20 iterations with Moving Average Filtering

In Fig. 4.2 the Almouti STBC coding based system and modulation scheme is Phase Shift Keying. The Phase Shift Keying modulation scheme is simulated with different variations e.g. 2-PSK, 4-PSK and 8-PSK. The whole simulation repeated for 20 times. The simulation results shows that BER performance is good for 2-PSK with moving average filter.

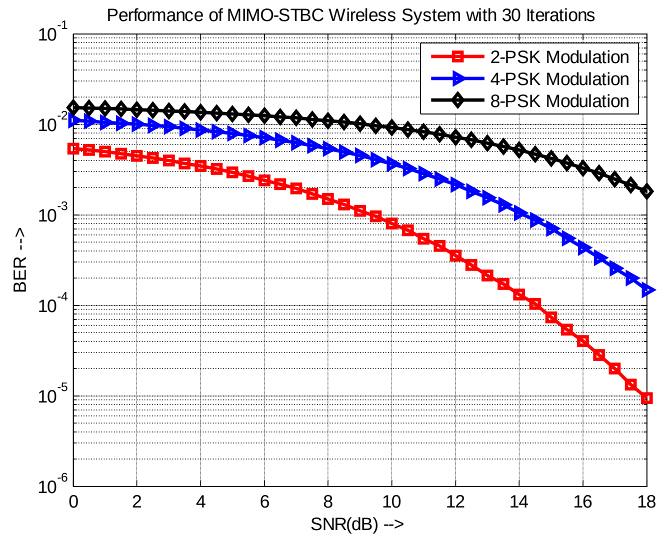

Fig. 4.3 BER performance of the MIMO system with 2, 4 and 8-PSK modulation and 30 iterations with Moving Average Filtering

In Fig. 4.3 the Almouti STBC coding based system and modulation scheme is Phase Shift Keying. The Phase Shift Keying modulation scheme is simulated with different variations e.g. 2-PSK, 4-PSK and 8-PSK. The whole simulation repeated for 30 times.

CONCLUSION AND FUTURE WORK

The wireless communication system with better end to end performance is proposed and implemented on simulation tool. The outcomes of the proposed methodology are explained in the previous section of the paper. From the simulation results it is clear that the system simulated with MIMO technology and the application of moving average filtering making performance far better than normal.

The better modulation approach make system more robust and the use of some efficient filtering technique will definitely enhances the system outcomes.

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