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A REVIEW ON SPATIAL MODULATION

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Abstract-This paper presents a review on spatial modulation(SM) for MIMO systems. During these decades, multiple input multiple output technique is a key technology. Its higher data rate, multiplexing, transmit diversity make them so. These benefits are achieved by the MIMO system at the cost of higher system complexity, higher power consumption and so on. At this context SM MIMO arises as a solution to whole of these problems. SM is a new modulation concept that simultaneously exploits signal constellation and spatial constellation.

Index Terms—spatial modulation, MIMO

I. INTRODUCTION

In these recent years there is a rapid growth in the demand for wireless communication. All the subscribers demand high data rate and high spectral efficiency. Even though MIMO technique provide these there are a lot of disadvantages like power consumption is higher because all the antenna are active for all the time when a data is transmitting and receiving also this makes the system bulky. Another disadvantage is that synchronization requirements are more stringent in this case. Thus a search in need of these requirements results in the innovation of new technique spatial modulation(SM). SM can be considered as MIMO concepts that take advantage of all the antennas but using only limited number of antennas for transmitting data. This is one of the unique character of SM-MIMO. Thus SM-MIMO provides advantages like higher spectral efficiency, high data rate and lower power consumption with small number of active transmission antennas.

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II. SPATIAL MODULATION

Basic idea of SM is that a block of information is mapped into two blocks

- One block indicate the antenna index i.e. from which antenna the information has been send
- Next block represents the data

The net result of embedding part of the information to be transmitted into the position of the transmit-antenna is a hybrid modulation and MIMO technique in which the modulated signals belong to a tridimensional constellation diagram, which jointly combines signal and spatial information. [13].

A simple example is shown in Fig. 1 for a linear antenna-array with *Nt* = 4 and a QPSK (Quadrature Phase Shift Keying) modulation [13].

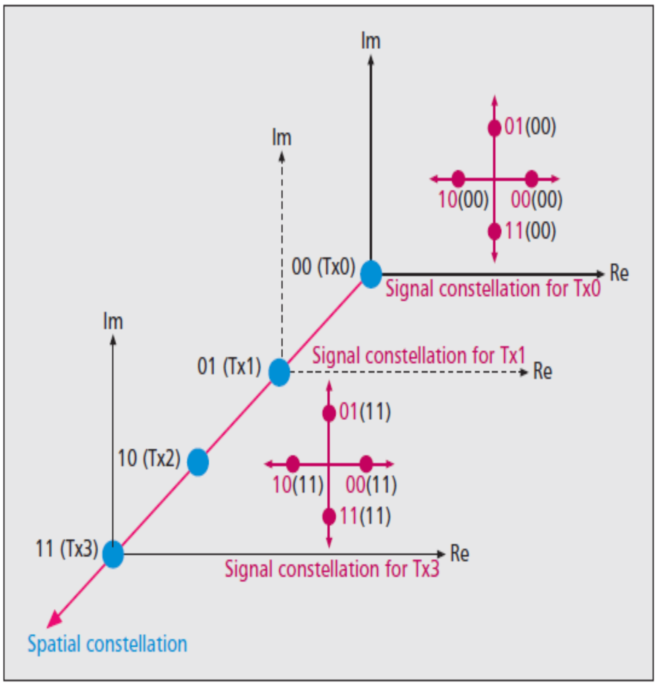
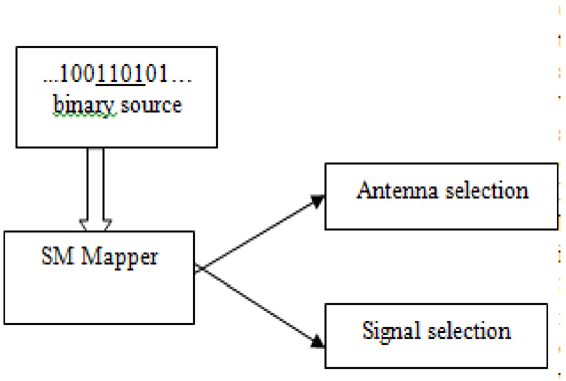


Figure 1. Tridimensional constellation diagram of SM with N_t=4 and M= 4[13]

At the transmitter of SM the incoming information bits are divided in to $\log_2 N_t + \log_2 M$ blocks, where N_t is the number of transmitting antennas and M is the size of complex signal constellation diagram. These sub-blocks are then divided into two blocks with $\log_2 N_t$ and $\log_2 M$ bits each. For example, consider QPSK modulation and let $N_t = 4$



At the receiver according to the ML principle the Euclidean distance between the received signal and the set of possible signals are calculated and select the closest one

III. BENEFITS OF SM MIMO

The general system for SM MIMO and the benefits are shown in figure [2] [17]

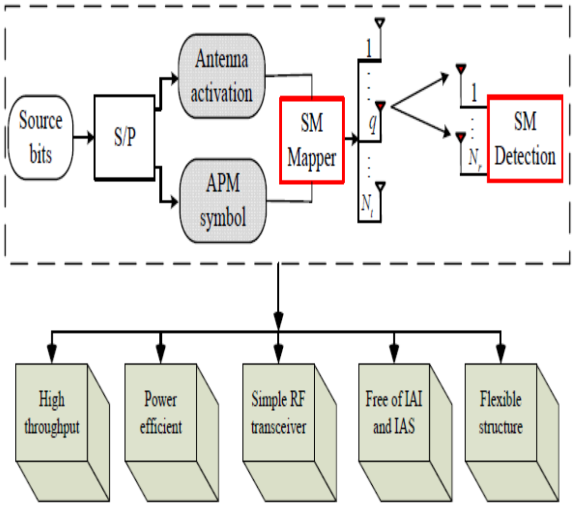


figure 2 :Benefits of SM MIMO

IV. OVERVIEW ON RECENT WORKS

In [1], analysis of SM-MIMO over generalized fading channels was proposed. The authors have derived important information about the performance of SM over fading channels, including the effect of fading severity, the achievable diversity gain, along with the impact of the signal constellation diagram. It has been shown that the modulation scheme used in the signal constellation diagram significantly affects the performance, and for multiple-output systems with SM. Two selection schemes are proposed in the paper. By configuring the selection problem as a tree search problem and adopting tree pruning technique, the first selection scheme attains low complexity while obtaining the optimal solution. In the second scheme, by pruning the less dominant nodes and approximating the signal constellation, the Euclidean distance computation is converted to a simple table look-up operation. Combining this with the first scheme, the second scheme attains even lower complexity without optimality guarantee. Besides configuration selection, the precoder design is investigated, and a precoder design approach is proposed to improve the system.

In [11], SM has been applied to OFDM. The authors have been derived the closed-form analytical performance of SM in i.i.d. Rayleigh flat-fading channels. It has shown that the SM Scheme was more robust to the presence of Rician fading, single carrier (SC), and multiple carrier (MC), as compared to V-BLAST. In addition, when comparing the performance of SM and Alamouti, SM was shown to have a better or, in the worst case, a similar performance for all the simulated cases. The performance of SM degrades in the presence of a LOS component, whereas the performance of Alamouti improves in such channel conditions. Another limitation of SM is the increase in spectral efficiency by the base-two logarithm of the total number of transmits antennas, as compared to a linear increase for the V-BLAST system.

In [12], authors have proposed a jointly mapped spatial modulation (JM-SM) scheme to break through the constraint on the number of transmit antennas in traditional SM systems. It was done by jointly mapping the transmit information bits to 3-D constellation points. A 3-D constellation design scheme for a JM-SM is analyzed and established by minimizing the system average bit error probability (ABEP). It was shown that the proposed JM-SM maintains all the advantages of the conventional SM. In addition, it allows the transmitter to be equipped with arbitrary number of antennas, which offers great design flexibility.

In [16], a unified adaptive transmission scheme – adaptive spatial modulation that allocates information into signal space and spatial dimension in order to maximize the overall channel capacity for single RF chain MIMO was proposed. The adaptive spatial modulation is realized by using Huffman coding, i.e., designing variable length codes to activate the transmit antenna with different probabilities. By optimizing channel capacity the optimal antenna activation probability was derived. To make the optimization tractable, closed form upper bound and lower bound are derived as the effective approximations for channel capacity. Here the idea is to assign binary codes to spatial symbols (antenna index). The antenna information bits are mapped to its corresponding transmit antenna according to the constructed Huffman code. Also the authors showed that the adaptive spatial modulation becomes significantly better than both conventional spatial modulation and transmit antenna selection schemes.

V. CONCLUSION

In this paper a review on MIMO with SM was presented. Various works on SM-MIMO has summarized. Unique advantage of SM is that the position of transmitting antenna is used for conveying information. From the evaluation on various works over SM shows that compare to the conventional MIMO, it offers higher spectral efficiency, reduces complexity, and lowers the energy consumption. Still now SM is in the immature stage and several investigations are required to fully understand the potential of SM.

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