ISSN: 2321-8169
84 – 85

Introduction to Generalised Spatial Modulation

Prof. K.S. Solanki
Ujjain Engineering College, Ujjain (M.P.)
E-mail- khemsingh_solanki@rediffmail.com

Abhilasha Singh
Ujjain Engineering College, Ujjain (M.P.)
E-mail- abhilasha_sng9@yahoo.com

Abstract**—**In this paper generalized spatial modulation technique is introduced. This is a new technique for MIMO system. It enhances the spectral efficiency and reduces BER. GSM enhances the system performance.

Keywords*-Spatial modulation,generalised spatial modulation(GSM),MIMO.*

*****

I. Introduction

The need to improve the spectral efficiency and reliability of radio communication is driven by the ever increasing requirement for higher data rates and improved Qos (Quality of service) across wireless links[1]. Higher data rate and better spectral efficiency are two important parameter for next generation cellular communication. Multiple input multiple output (MIMO) system is very helpful technique for achieving higher data rate and better spectral efficiency by transmitting multiple data streams from multiple antennas. However capacity of the MIMO system depends on transmit and receive antenna spacing, transmit antenna synchronization and used algorithm.

Spatial modulation (SM) is one of the new MIMO technique. In SM only one antenna is active at a time. This completely avoids the interchannel interference (ICI) and increases spectral efficiency. At the receiver side, detector determines active antenna index and sent data symbol. Only single active antenna is the limitation of SM. Generalised spatial modulation (GSM) overcome the limitation of SM. SM is the special case of GSM. In GSM multiple antenna is active at a time. In this technique same information bits are transmitted through multiple antennas. This avoids ICI and increases spectral efficiency. It enhances bit error rate (BER) performance of the system.

II. GSM System Model

Generalised spatial modulation (GSM) uses multiple antennas to transmit same information bits. Considering the N_t transmit antennas from which N_u active antennas at each time instant. For transmission of data the number of possible combinations must be a power of two. Therefore only $N_c = 2^{m_l}$ combinations can be used.

Where, $m_l = \left\lfloor \log_2 \binom{N_t}{N_u} \right\rfloor$ and $\lfloor . \rfloor$ is the floor operation.

The GSM model is shown in fig. 1. The input bits are mapped to a spatial symbol. First m_l bits are mapped to the antenna combination and remaining m_s bits are modulated using $M-QAM$ modulation, where $M = 2^{m_s}$. In the example $N_t = 5$ and $N_u = 2$ are assumed. In fig. 1 $g(n) = [0\ 1\ 0\ 1]$ is the data which is to be transmitted. Using GSM mapping table $g(n)$ are mapped to $x(n) = [+1\ 0\ 0 + 1\ 0\ ]$. In general, the number of bits that can be transmitted using GSM is given by,

$$m = m_l + m_s = \left\lfloor \log_2 \binom{N_t}{N_u} \right\rfloor + \log_2 M$$

$H$is the Rayleigh flat fading wireless channel. The GSM modulated signal is transmitted through H. Hisidentical and independently distributed (i.i.d.) Gaussian random variable with zero mean and unit variance.

The received signal at any given time is

$$y = h_l^{'} s + v$$

Where, y is the received signal.

$$h_l^{'} = \sum_{n=1}^{N_u} h_{l_n}$$

$h_{l_n}$is the channel vector.

$v$is the AWGN vector and zero-mean and σ_n^2 variance.

At the receiver the spatial symbol and data symbol are jointly decoded using the ML principle as follows:

$$[\tilde{l}, \tilde{s}] = \arg\max_{l,s} p_y\,(y|x, H)$$

$$= \arg\min_{l,s} \sum_{i=1}^{N_r} \left| y_i - h_{l,s}^{'} s \right|^2$$

Where,

$$p_y(y|s, l, H) = \frac{1}{(\pi\sigma_n^2)^{N_t}} \exp\left(\frac{-\|y - h_l^{'} s\|_F^2}{\sigma_n^2} \right)$$

is PDF of y conditional on s, l and H. $\|.\|_F^2$is the frobenius norm.

ISSN: 2321-8169
84 – 85

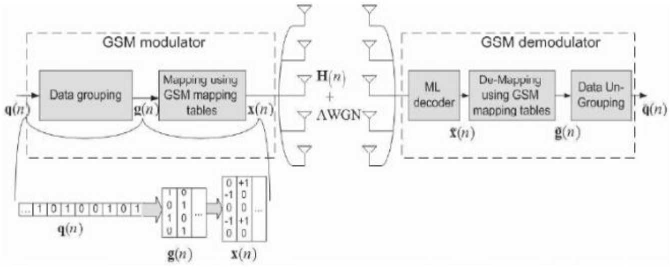

Fig. 1Generalised spatial modulation system model. At each instant four bits are transmitted. Three bits are encoded in the indices of the combination of transmit antennas and one bit is conveyed inthe signaldomain usingBPSK modulation.

Table 1 GSM mapping table for $N_t = 5$, $N_u = 2$ and BPSK modulation.

Group Bits	Antenna combination (l)	Symbol (s)
0000	(1,2)	-1
0001	(1,2)	+1
0010	(1,3)	-1
0011	(1,3)	+1
0100	(1,4)	-1
0101	(1,4)	+1
0110	(1,5)	-1
0111	(1,5)	+1
1000	(2,3)	-1
1001	(2,3)	+1
1010	(2,4)	-1
1011	(2,4)	+1
1100	(3,5)	-1
1101	(3,5)	+1
1110	(4,5)	-1
1111	(4,5)	+1

III. Conclusion

In this paper generalized spatial modulation is introduced. In GSM same symbols are send from more than one transmit antenna at a time. SM is restricted to the number of transmit antenna. Only one antenna is active at a time. GSM can achieve higher spectral efficiency as compared to SM. GSM avoids ICI by transmitting same symbols from multiple transmit antennas. BER performance of SM and GSM are almost same. Improvement in spectral efficiency is achieved but complexity of the system is also increased. Complexity increases due to increase in the number of transmit antenna. In this paper ML based receiver is also presented. This receiver determines the antenna combination used and transmitted complex symbol.

IV. References

[1] R. Mesleh, H. Haas, C. W. Ahn, and S. Yun, Spatial modulation - A new low complexity spectral e ciency enhancing technique, Int. Conf. on Commun. and Netw. in China, 2006., Oct. 2006.

[2] R. Mesleh, H. Haas, S. Sinanovic, C. W. Ahn, and S. Yun, Spatial modulation, IEEE Trans. on Veh. Technol., vol. 57, no. 4, pp. 2228 2241, July 2008.

[3] J. jaganathan, A. Ghrayab, L. Szczecinski, and A. Ceron, "Space shift keying modulation for MIMO channels," IEEE Trans. Wireless Commun., vol.8, no. 7, pp. 3692-3703, Jul 2009.

[4] J. jaganathan, A. Ghrayab, L. Szczecinski, and A. Ceron,"Spatial modulation: optimal detection and performance analysis," IEEE Commun. Lett., vol. 12, no. 8, pp. 545-547, Aug 2008.

[5] M. Di Renzo and H. Haas, "Bit error probability of SM-MIMO over generalized fading channels," IEEE Trans. Veh.Technol., vol. 61, no. 3 pp. 1124-1144, Mar. 2012.