INTERNATIONAL JOURNAL OF SCIENTIFIC PROGRESS AND RESEARCH (IJSPR) ISSN: 2349-4689
Volume-18, Number - 01, 2015

Diversity Optimized Almouti STBC Wireless System Using SUI Model and m-ary PSK Scheme

Hareesh Athanere[1], Prof. Ambikesh Prasad Gupta[2], Dr. Shilpi Sharma[3]
[1]M. Tech. Scholar, [2]Research Guide, [3]HOD
Department of Electronics and Communication Engineering, Bhopal Institute of Technology, Bhopal

Abstract - The wireless communication system utilizing the space diversity has an interest in modern communication system to deliver high performance to the users. The error rate is the major challenge to fight against the increasing use of mobile devices. As the obstacles and microwaves are increasing day by day the same affecting each other, the result is interfering environment with lots of noises and distortions in the signal. In this paper we have modeled a wireless communication system utilizing the Alamouti Space Time Block Codes to transmit the signal in space with variations which is integrated with the antenna diversity with the 2 transmitter and 2 receiver antennas i.e. MIMO technology to receive more power than traditional single antenna system. Such system is analysed on the SUI environment which is a modern wireless channel model given by the scientists for modern communication technology. The outcomes of the proposed system clearly show the optimized BER than existing system.

Keyword - SUI, M-ary PSK, STBC, Antenna Diversity.

I. INTRODUCTION

In the last century, the advances in very large scale integration (VLSI) and digital signal processing (DSP) technologies have enabled the implementation of complicated algorithms and coding systems in small devices with low power consumption, as required in modern mobile communications. Such technical breakthroughs have promoted the rapid growth of the global market in wireless communication equipment and services. Furthermore, the demands for higher network capacity and improved performance of wireless communications are continuously growing. With the advent of applications such as multimedia data transmission (audio and video streams) or online gaming networks, a much higher spectral efficiency is needed to provide the services with adequate quality [1, 2]. As has been envisaged in [3], it is essential to plan and develop new communication technologies, in order to cope with the increasingly high demand for network capacity in the future wireless systems.

Hence, the development of faster and more reliable wireless techniques has became one of the most vibrant areas in communications engineering. However, this is a diffi cult task since wireless systems have to contend with signal fading, multipath propagation, interference, noise and limited bandwidth. According to Shannon's information theory, it is well known that the capacity represents the highest possible data rate that channel can support. Also, his classic formula for channel capacity is a function of bandwidth and signal to noise ratio (SNR) [4]. Increasing signal power and expanding channel bandwidth are two intuitive ways to improve capacity. Unfortunately, both of these ideas are impractical, as the power is generally constrained in mobile devices and the channel spectrum is usually limited by certain regulations. Thus, many approaches like advanced modulation and coding schemes have been proposed to offer higher spectral efficiency.

The concept of utilizing the degrees of freedom in the spatial domain through antenna arrays, which has emerged in the last few decades, is now being regarded as one of the strongest candidates for the next generation of wireless communications [5]. In particular, researchers have shown that schemes with multiple antennas on both sides (so called MIMO systems) can tremendously enhance the system throughput, reliability and coverage, without the necessity of extra power and bandwidth [6, 7]. MIMO systems have received considerable attention in the last decade due to their potential benefits, and related research has been very active in recent years, in both academia and industry [8, 9]. A testimony to this can be seen from recent standardizations for many commercial radio applications. Generally speaking, multiple antenna systems can be classified into two main categories: diversity systems and spatial multiplexing systems [12].

The main goal of a diversity scheme is to improve the error performance and hence the system reliability. The primary structure for spatial diversity consists of an antenna array at the receiver side only [13]. The idea is to provide multiple versions of the transmitted messages with different fading severity. The receiver then implements some combining algorithm. For example, the receiver can simply pick up the signal with the best SNR, this is the so called *selection diversity*. Alternatively, the receiver could use *maximum ratio combining*, which takes the sum of all the received signals weighted according to their SNR values. Such schemes are effective methods in combating multipath fading problems [14].

Space time coding (STC) is an extension of traditional spatial diversity, which aims to provide more reliable communication. While conventional meth ods use multiple antennas at the receiver only to combat fading effects, STC further enhances the gain by adding the utilization of transmit diversity. The two most well known techniques in this category are Space Time Trellis Codes (STTC) proposed in [15], and Space Time Block Codes (STBC) [16]. STTC can become very complicated as the number of antennas increases. The implementation of STBC (a well known example being the Alamouti scheme [16]), on the other hand, is relatively simple.

Hence, despite its performance loss as compared to STTC, STBC receives a lot of attention in the context of MIMO systems. Such schemes code the message in both space and time. In other words, replicas of the message are transmitted at a delayed time on different antennas. The initial structure proposed in [16] consist of two transmit and one receive antenna, and the idea was further generalized in [17] for systems with arbitrary numbers of antennas by using the theory of orthogonal designs. This type of configuration allows a very simple maximum likelihood decoding algorithm [18]. While diversity schemes can improve the error performance significantly, spatial multiplexing schemes, on the other hand, are capable of providing very high system throughputs. Such a scheme simply divides the incoming data into substreams and transmits them on different antennas. Modulation and coding for each transmit antenna occurs independently.

Thus, the overall throughput is raised as multiple data streams are sent simultaneously. In general, spatial multiplexing schemes can be classified into *openloop* or *closedloop* configurations, depending on the existence of a feedback mechanism.

II. SUI MODEL

In order to investigate the performances of OFDM based BWA an accurate channel model needs to be considered. Usually all the wireless channels are characterized by path loss (including shadowing), multipath delay spread, fading characteristics, Doppler spread, and co-channel and adjacent channel interference. Ricean distribution can be used for characterization of narrow band received signal fading. In this distribution the key parameter is the *K*-factor, which is defined as the ratio of the “fixed” component power and the “scatter” component power. An empirical model was derived from a 1.9 GHz experimental data set collected in a typical suburban environment for transmitter antenna heights of approximately 20 m [7]. The model presented in [7] is as follows:

$$K = F_s F_h F_b K_0 d \gamma u$$

,where F_s is a seasonal factor, F_h is the receiving antenna height factor, F_b is the beam width factor, Ko and γ are regression coefficients, *u* is a lognormal variable which has mean at 0 dB and a standard deviation of 8.0dB. Some values of the parameters are Fs as 1.0 in summer and 2.5 in winter respectively, K_0 and γ are regression coefficients($K_0 = 10$; $\gamma = -0.5$). The receiving antenna height factor F_h is defined by F_h= 0.46(h/3), where *h* is the receiving antenna height in meters, the beam width factor F_b is defined by F_b = (b/17)-0.62, where *b* is in degrees. The empirical model proposed in [7] has been confirmed by the experimental work presented in [8].

An independent set of experimental data was acquired in San Francisco Bay Area at 2.4 GHz and with similar antenna heights mentioned in [7] which has been reported in [8].It has also been shown that the experimental data presented in [8] very closely matches with the model presented in [7]. The narrow band *K*-factor distribution was found to be lognormal with the median as a simple function of season, antenna height, antenna beam width, and distance. The standard deviation was found to be about 8 dB. Using this model, it can be found that *K*-factor decreases as the distance from the antenna and the antenna beam width is increased. One of our focus is to determine *K*-factor that meets the requirement that 90% of all locations within a cell have to be served with 99.9% reliability. Calculating the *K*-Factor is quite complex as it involves path loss, delay spread, antenna correlation (if applicable), specific modem characteristics, and other parameters that influence system performance. However an approximated value can be calculated with much easier steps. First we select 90% of the users with the highest *K*-factors over the cell area. Secondly we can obtain the approximate value by selecting the minimum *K*-factor within the set.

This value of *K*-factor can be close or equal to 0. In Fig. 3 shows fading cumulative distribution functions (CDFs) for various *K* factors. For example, for $K = 0$ dB (i.e., linear $K = 1$) a 30 dB fade occurs, which is very similar to a Rayleigh fading case (i.e., linear $K = 0$). The significance of these fade probabilities actually depends on the system design such as whether diversity is included and the quality of service (QoS) being offered etc.

When multiple antennas are used at the transmitter and/or at the receiver, the channel can be characterized by a matrix (i.e., Multi-Input-Multi-Output or MIMO in short) system, which is a natural extension of the developments in antenna array based communication system.

III. PROPOSED METHODOLOGY

The proposed simulation model for the wireless Almouti scheme with the utilization of SUI channel model is given in the below fig. In the system we have analysed the proposed simulation model with M-ary PSK modulation to modulate the signal. Here this modulation scheme play very important role to fight against the noises and the interferences.

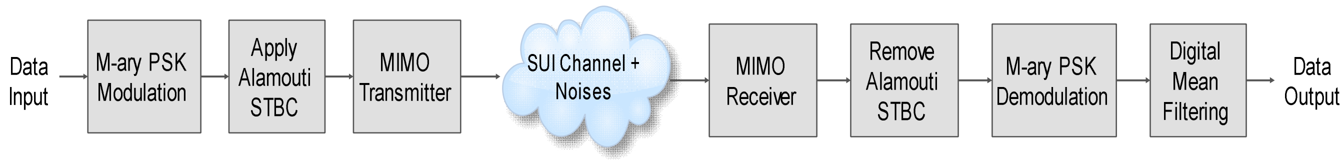

Fig. 3.1 Block Diagram of the Proposed Model

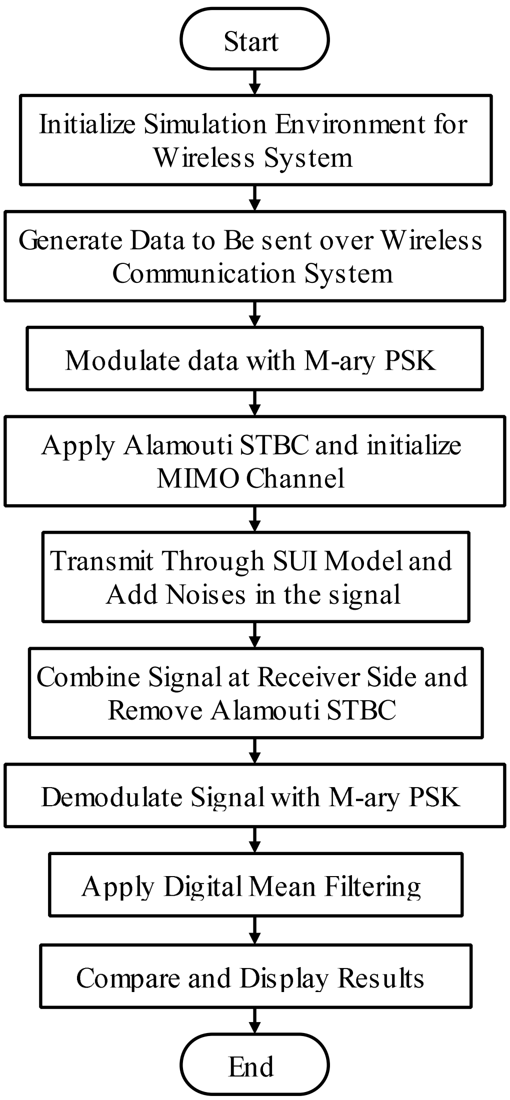

Fig. 3.2 Flow Chart of the Proposed Model

Further the signal is modified with space time block codes which changes the information signal in space and time format, this has been a trick to split the whole information into two parts so that the effect of noise can be as low as possible. Now the signal is transmit through the multiple antenna system here we have used two transmitter and two receiver antennas.

The MIMO system that is antenna diversity significantly enhances the reception of power at the receiver side because of the space is covered by the multiple antennas.

For the channel model we taken reference of the latest wireless channel model given by the scientists of Stanford university and explained in the previous section.

For the consideration of noises and obstacle and distortions introduced by the wireless media. After transmission through wireless channel this signal received at the receiver side and the reverse process is done which extract the signal from multiple antennas and combine them.

After Demodulation of signal the Digital Mean Filtering is applied to further reduction of error of the signal.

Above explained system is implemented on the MATLAB simulation tool and the execution of the implemented Matlab code is shown in the flowchart with step by step execution.

IV. SIMULATION RESULTS

The proposed methodology explained in the previous section is simulated on the MATLAB and the system analysis on the bit error rate is done. The performance of the proposed system between BER and SNR is shown in the subsequent figures.

In Fig. 4.1 performance of the proposed multiple input multiple output (MIMO) space time block code(STBC) with Stanford University Interim(SUI) channel model system is analysed and BER vs SNR is shown with 2 iterations. The whole system is tested for 2-PSK, 4-PSK and 8-PSK and found that the system perform well with 8-PSK Modulation and optimum value is 10^{-5}.

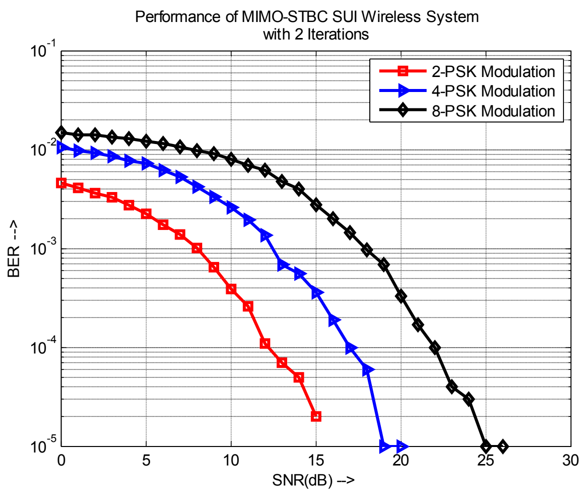

Fig. 4.1 Performance of the system with SUI model and 2 iterations

In Fig. 4.2 performance of the proposed multiple input multiple output (MIMO) space time block code(STBC) with Stanford University Interim(SUI) channel model system is analysed and BER vs SNR is shown with 4 iterations. The whole system is tested for 2-PSK, 4-PSK and 8-PSK and found that the system perform well with 2-PSK Modulation and optimum value is $5x10^{-6}$.

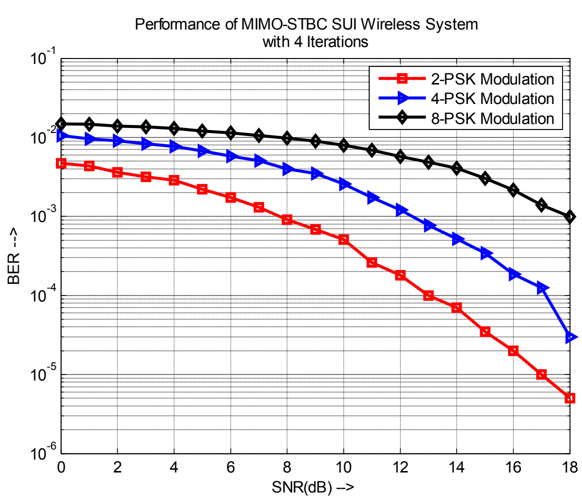

Fig. 4.2 Performance of the system with SUI model and 4 iterations

In Fig. 4.3 performance of the proposed multiple input multiple output (MIMO) space time block code(STBC) with Stanford University Interim(SUI) channel model system is analysed and BER vs SNR is shown with 8 iterations. The whole system is tested for 2-PSK, 4-PSK and 8-PSK and found that the system perform well with 2-PSK Modulation and optimum value is $2.5x10^{-6}$.

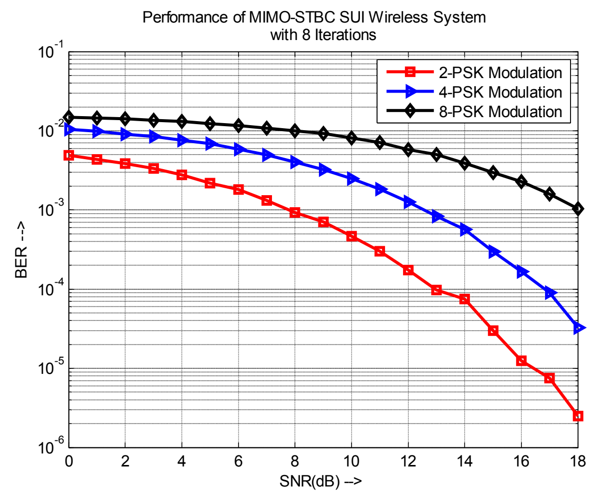

Fig. 4.3 Performance of the system with SUI model and 8 iterations

V. CONCLUSION AND FUTURE SCOPE

From the above proposed system and result analysis it can be conclude that the wireless system with MIMO technology and the utilization STBC codes under the SUI channel environment perform well with the 2-PSK modulation and the optimum value of BER is $2.5x10^{-6}$. The noise and effect of fading is reduced with the Space Time coding of the signal which separates the signal into multiple parts which has an inherent security for the signal. Further noises is reduced with the Digital Mean Filter which takes averages of the multiple samples and smoothen the glitches presents in the signal. In this paper the proposed system can be further improved in terms of noise immunity as well as better error rate with the integration of more complex and accurate modulation techniques and digital filtering solutions. Such system can targeted for variety of wireless applications such as mobile communications and other mobile information sharing systems.

REFERENCES

[1] Sahrab, A.A.; Marghescu, I., "MIMO-OFDM: Maximum diversity using maximum likelihood detector," in *Communications (COMM), 2014 10th International Conference on* , vol., no., pp.1-4, 29-31 May 2014.

[2] Riera-Palou, F.; Femenias, G., "On Detection Strategies for Linearly Precoded MIMO-OFDM Systems with CSIT,"

in Wireless Communications, IEEE Transactions on , vol.12, no.12, pp.5979-5991, December 2013

[3] Abhishek Sharma, and Anil Garg, "BER Analysis Based on Transmit and Recieve Diversity Techniques in MIMO-OFDM System," IJECT, Vol. 3, Issue I, Jan-March 2012.

[4] Yavanoglu, A.; Ertug, O., "Spectral and power efficiency of IEEE802.11n MIMO-OFDM WLAN systems using higher-order space-multimode diversity compact stacked circular microstrip antenna arrays," in Signal Processing and Communications Applications (SIU), 2011 IEEE 19th Conference on , vol., no., pp.319-322, 20-22 April 2011

[5] Riera-Palou, F.; Femenias, G., "CRC-aided iterative optimal detection for MIMO-OFDM systems with linear precoding," in Signal Processing Conference, 2011 19th European , vol., no., pp.1628-1632, Aug. 29 2011-Sept. 2 2011

[6] Jaya Kumari J, "MIMO-OFDM for 4G Wireless Systems," International Journal of Engineering Science and Technology, Vol. 2, No. 7, pp. 2886-2889, 2010.

[7] Jiang Xuehua, and Chen Peijiang, "Study and Implementation of MIMOOFDM System Based on Matlab," IEEE Computer Society: International Conference on Information Technology and Computer Science, pp. 554-557, 2009.

[8] Karami, E.; Juntti, M., "A near optimum joint detection and decoding algorithm for MIMO-OFDM channels," in Wireless Pervasive Computing, 2008. ISWPC 2008. 3rd International Symposium on , vol., no., pp.223-223, 7-9 May 2008

[9] Bin Yang; Ping Gong; Shaopeng Feng; Hanfeng Zhang; Yonghua Li; Weiling Wu, "Monte Carlo Probabilistic Data Association Detector for SFBC-VBLAST-OFDM System," in Wireless Communications and Networking Conference, 2007.WCNC 2007. IEEE , vol., no., pp.1502-1505, 11-15 March 2007

[10] McKay, M.R.; Collings, I.B., "Layered space-frequency bit-interleaved coded modulation for MIMO systems," in Personal, Indoor and Mobile Radio Communications, 2005. PIMRC 2005. IEEE 16th International Symposium on , vol.2, no., pp.1106-1110 Vol. 2, 11-14 Sept. 2005

[11] Allert van Zelst, and Tim C. W. Schenk, "Implementation of a MIMO OFDM-Based Wireless LAN System," IEEE Transactions on Signal Processing, Vol. 52, No. 2, pp. 483-494, Feberuary 2004.

[12] A. F. Naguib, N. Seshadri, and A. R. Calderbank, \Increasing data rate over wireless channels," IEEE Signal Processing Mag., pp. 76{92, May 2000.

[13] W. Mohr and W. Konhauser, \Access network evolution beyond third generation mobile communications," IEEE Commun. Mag., pp. 122{133, Dec. 2000.

[14] L. M. Correia and R. Prasad, \An overview of wireless broadband com- munications," IEEE Commun. Mag., pp. 28{33, Jan. 1997.

[15] T. M. Cover and J. A. Thomas, Elements of Information Theory, 2nd ed. Wiley-Interscience, 2006.

[16] A. J. Paulraj and C. B. Papadias, \Space-time processing for wireless communications," IEEE Signal Processing Mag., pp. 49{82, Nov. 1997.

[17] A. Lozano, F. R. Farrokhi, and R. A. Valenzuela, \Lifting the limits on high-speed wireless data access using antenna arrays," IEEE Commun. Mag., pp. 156{162, Sept. 2001.

[18] S. D. Blostein and H. Leibs, \Multiple antennas systems: Their role and impact in future wireless access," IEEE Commun. Mag., pp. 94{101, July 2003. 153

[19] D. Gesbert, M. Sha¯, D.-S. Shiu, P. Smith, and A. Naguib, From theory to practice: An overview of MIMO time-space coded wireless systems," IEEE J. Select. Areas Commun., vol. 21, pp. 281{302, Apr. 2003.

[20] A. J. Paulraj, D. A. Gore, R. U. Nabar, and H. Bolcskei, \An overview of MIMO communications - a key to gigabit wireless," Proc. IEEE, vol. 92, no. 2, pp. 198{218, Feb. 2004.

[21] Introduction to MIMO systems," Application Note 1MA102, Rohde and Schwarz, June 2006.

[22] G. L. Stuber, J. R. Barry, S. W. McLaughlin, Y. Li, M. A. Ingram, and T. G. Pratt, \Broadband MIMO-OFDM wireless communications," Proc. IEEE, vol. 92, no. 2, pp. 271{294, Feb. 2004.

[23] I. Berenguer and Z. Wang, \Space-time coding and signal processing for MIMO communications," J. Comput. Sci. Tech., vol. 18, no. 6, pp. 689{702, 2003.

[24] G. L. Stuber, Principles of Mobile Communications, 2nd ed. Norwell, MA: Kluwer, 2002.

[25] T. S. Rappaport, Wireless Communications: Principles and Practice, 2nd ed. Upper Saddle River, NJ: Prentice-Hall, Inc., 2002.

[26] V. Tarokh, N. Seshadri, and A. R. Calderbank, \Space-Time codes for high data rate wireless communication: Performance criterion and code construction," IEEE Trans. Inform. Theory, vol. 44, pp. 744{765, Mar. 1998.