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PERFORMANCE OF CHAOS COMMUNICATION SYSTEM USING MIMO TECHNIQUES AND OFDM

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ABSTRACT

Due to the security and advantage of chaos communication system like its characteristics such as non predictability, non- periodic, wide band and easy implementation, chaos communication systems are being studied continuously. In this research we are going to use chaos communication to improve bit error rate (BER) performance of the system. The existing research says that the BER performance of the system is bad and it is the major disadvantage of the chaos communication system. We propose chaos communication system using 2X2 MIMO technique which uses correlation delay shift keying (CDSK) and BER performance is evaluated over Rayleigh MIMO fading channel. We are using MIMO encoding technique because the capacity of data is proportional to the number of antenna, if many antennas are applied to chaos communication system. So it is good way applying multiple-input and multiple-output (MIMO) to the chaos communication system and then evaluate BER performance by applying chaos map. The demand for high data rate without interference is increasing very much. So we are using the concept of Orthogonal Frequency Division Multiplexing (OFDM) which provides high data rates as well as much more bandwidth efficiency as compared to other modulation techniques.

Keywords- **Chaos communication system, MIMO, OFDM**

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I. INTRODUCTION

Chaos communications is an application of chaos theory which provides security in transmission of information. Chaos communication system is more secure now-a-days. In chaos communication system security is high due to its characteristics such as non- periodic, wide-band, non predictability and easy implementation [1] [2]. The main advantage of chaos communication system is that it depends on initial conditions. It is very sensitive to initial conditions, if initial conditions are changed then chaos signal is changed to different signal [3]. Unless the users will know the initial condition, the chaos signal is not exact and it will become
impossible to predict its value. That's why chaos communication system is non-predictable and due to this reason the security level of chaos communication system increases.

Though chaos communication is secure communication and has many advantages, the system also has a disadvantage on Bit Error Rate (BER) performance. The BER performance of chaos communication system is worse. There are many research work done to improve the BER performance [4] [5].

The BER performance of chaos communication system is improved by applying MIMO (Multi Input Multi Output) system [7], because in chaos communication system the message signal is spread and has many transmitted symbols. MIMO technique is used to transmit information signal using multiple antennas by multiple paths. MIMO encoding technique is used because the capacity of data is proportional to the number of antenna, if many antennas are applied to chaos communication system. At the receiver side the signals from different is added to receive the original desired output [8] [1]. In this paper, we propose chaos communication system using 2X2 MIMO technique which uses correlation delay shift keying (CDSK) and BER performance is evaluated over Rayleigh MIMO fading channel. We are using Alamouti STBC encoding of MIMO in order to improve the BER performance of the system. Also, the Zero Forcing detection algorithm is used [1] [9].

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In wireless mobile communication Inter-symbol Interference is the major problem. To reduce the interference and to improve the efficiency, we are using the concept of Orthogonal Frequency Division Multiplexing (OFDM) in this research. OFDM provides much higher data rates than conventional modulation techniques [10]. In OFDM, multiple sub-carriers are used which are orthogonal from each other. Each channel is broken into multiple sub-carriers. The modulation occurs at Inverse Fast Fourier Transform (IFFT) of the transmitter. The IFFT is used to modulate each sub-channel onto the appropriate carrier.

II. SYSTEM OVERVIEW

The proposed model of Chaos Communication system transmitter is shown in Figure 1 and Chaos communication system receiver is shown in Figure 2. We are going to simulate each block in MATLAB. We are using MATLAB version R2012a 7.14.0.739.

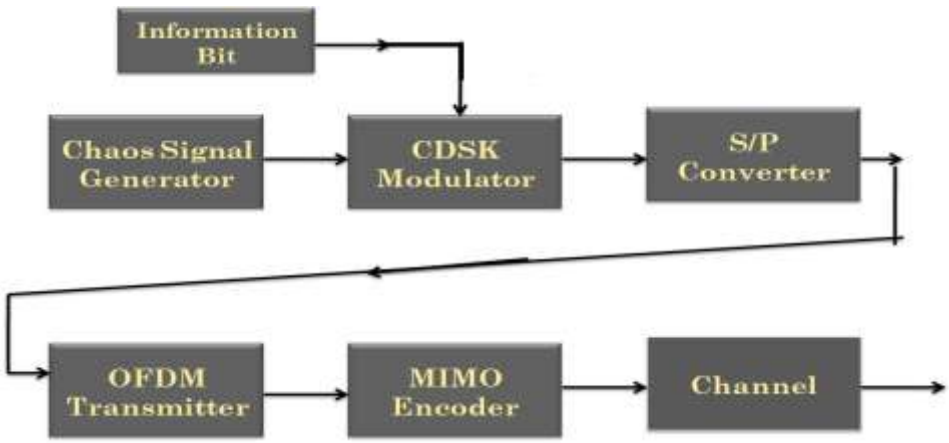

Fig. 1 chaos communication system Transmitter

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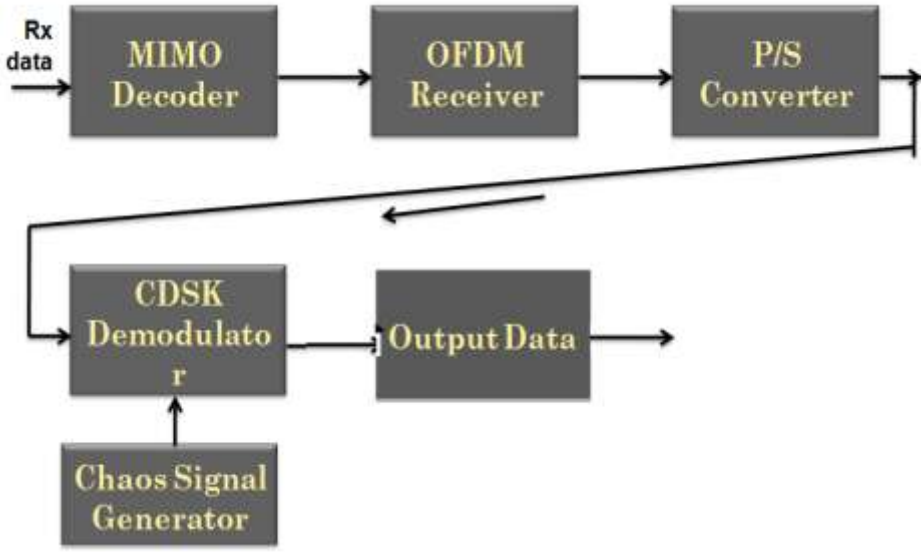

Fig. 2 chaos communication system Receiver

A. Chaos Signal Generator

The chaos signal is generated by using a Henon map. The Henon map is a discrete time dynamical system that exhibits chaotic behavior. The Hénon map takes a point (x_n, y_n) in the plane and maps it to a new point

$$\begin{cases} x_{n+1} = 1 - ax_n^2 + y_n \\ y_{n+1} = bx_n. \end{cases} \quad (1)$$

The henon map depends on two parameters a and b. the standard values of a and b are 1.4 and 0.3 respectively. For these standard values the Henon map is shows chaotic behaviour. The generated chaos signal is shown in figure 3.

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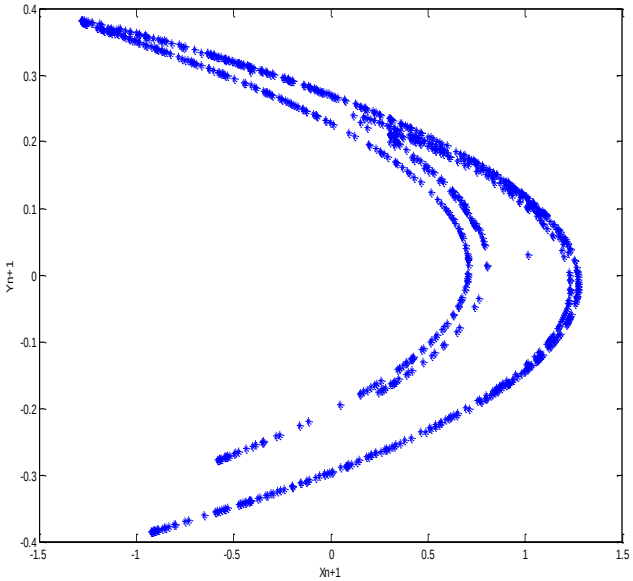

Fig. 3 chaos signal (Henon Map)

B. Correlation delay shift Keying system

Figure 4. shows transmitter of CDSK system. It consists of a chaos signal generator, a delayed unit, a multiplier and a adder. The chaos signal is delayed and multiplied by information bits. Then the original chaos signal and multiplier output is added and it is transmitted.

$$S_i = x_i + b_i x_{i-L} \quad \ldots\ldots\ldots(2)$$

Equation (2) shows the transmitted signal from the transmitter.

Where L= delay time

x_i= original chaos signal

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$b_i x_{i-L}$ = delayed chaos signal

M= spreading factor

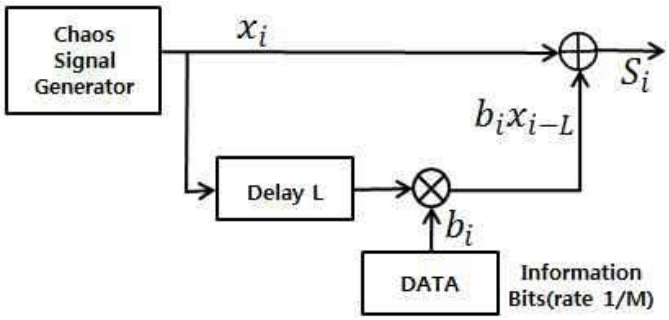

Fig.4. Transmitter of CDSK system

Figure 5 shows receiver of CDSK system. The receiver is correlator based to recover the symbol. The received signal and delayed received signal are multiplied and added as much as spreading factor. Then this signal is passed through the threshold and then it is decoded to recover the information signal.

$$S = \sum_{i=1}^{M} r_i r_{i-L} \quad \ldots\ldots(3)$$

Where M means spreading factor, the information bit that is spread as much as spreading factor.

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Equation (3) indicates output value of correlator of CDSK system. At this time, information bits is possible to recover when delay time (L) and spreading factor (M) have to exact value that is used in transmitted signal.

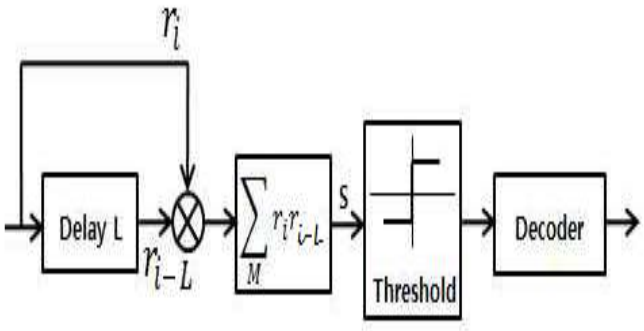

Fig.5. Receiver of CDSK system

C. MIMO System

CDSK system is applied to MIMO system. MIMO system is a system which is used to increase the capacity of the system. It

Uses multiple antennas to transmit and receive the signal. In this paper we are going to use Alamouti STBC of MIMO system with 2 transmit and 2 receive antennas (see Figure 6).

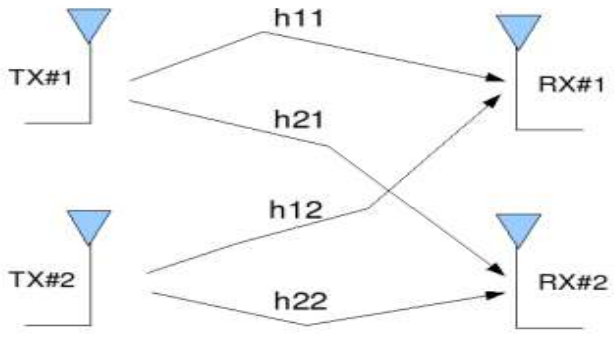

Fig. 6. 2 Tx 2 Rx Alamouti STBC

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As multiple signals are transmitted through multiple antennas, the received signal includes desired signal in addition to transmitted signals from other antennas. So to detach the desired signal MIMO detections algorithms are used. In this paper we are using Zero Forcing algorithm. The Zero-Forcing Equalizer applies the inverse of the channel frequency response to the received signal, to restore the signal after the channel.

D. OFDM System

In OFDM system, the carriers are orthogonal with each other. Orthogonality between two signals means that the signals does not interfere with each other and in specified time intervals, they are independent of each other. In OFDM, the carriers are placed as near as possible which maintains the property of orthogonality. The frequency domain of an OFDM system is represented in the diagram below (Figure 6).

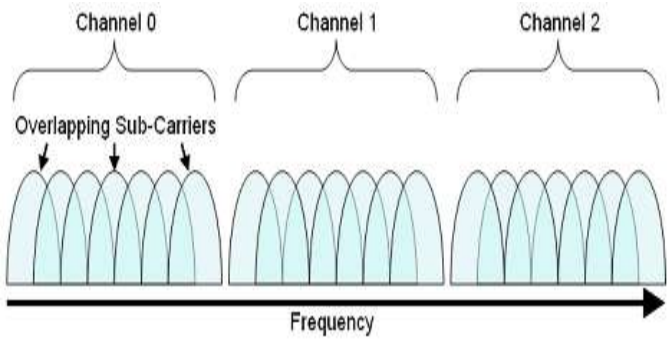

Fig.6. OFDM

The FEC code we are using in this research is convolution code. Convolutional codes work on bit or symbol streams of arbitrary length. They are used to further control the possibility of errors in the system.

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III. RESULT

In this paper, BER performance of chaos system is evaluated by applying CDSK system by applying 2x2 MIMO with zero forcing in Rayleigh fading channel. the spreading factor is decided on 30.

In figure 6 , the BER performance of CDSK system by applying MIMO with zero forcing is shown.

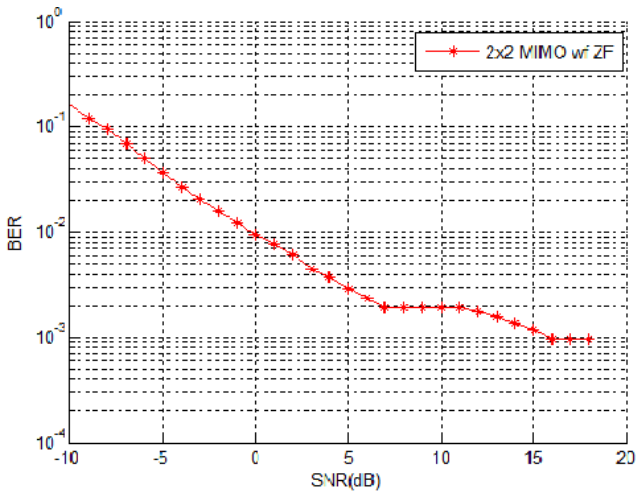

Fig.7. BER performance of 2x2 MIMO with ZF

In figure 8, the BER performance of CDSK system by applying MIMO with zero forcing using OFDM is shown. At SNR equal to 1 dB, the BER performance of 2x2 MIMO with zero forcing and 2x2 MIMO with zero forcing using OFDM is similar. But after 1 dB the BER performance of 2x2 MIMO with zero forcing using OFDM is superior.

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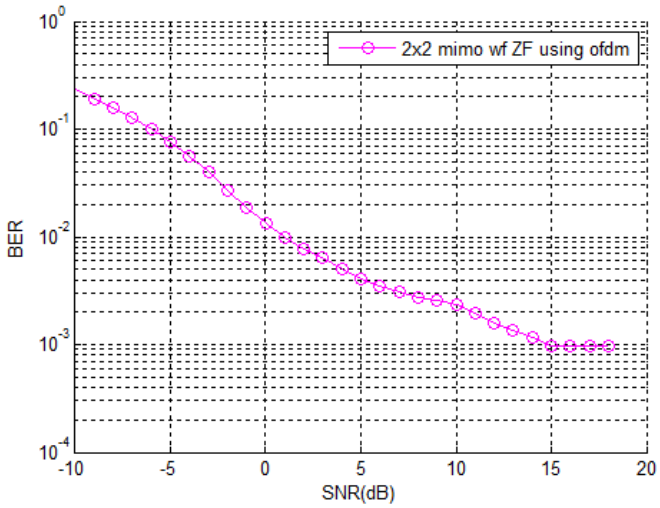

Fig.8. BER performance of 2x2 MIMO with ZF using OFDM

IV. CONCLUSION

The objective of this research is to utilize the properties of chaotic signals to implement secure communication. The fact that chaotic signals were aperiodic, broadband and sensitive to initial conditions was important for them to be utilized in security. In this paper, in Rayleigh fading channel, BER performance is evaluated in CDSK system by applying 2x2 MIMO with zero forcing detection algorithm. The information signal in chaos communication system is spread according to the characteristics of chaos map; therefore chaos system transmits many symbols. So, study of chaos system is necessary for improving data rate. MIMO (Multi Input Multi Output) system transmits data by several paths using several antennas. And, in receiver part, it is a technique which can reduce interference by detecting received signal at each path, and make better each data rate. In this research we conclude that the BER performance of CDSK 2x2 MIMO systems can be improved by applying OFDM mechanism to the chaos communication system. We find that the BER performance is much improved when we use 2x2 MIMO with OFDM. The OFDM concept is used to improve high data rates.

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