ISSN: 2349-7300
ISO 9001:2008 Certified
International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences (IJIRMPS)
Volume 1, Issue 1, October 2013

A New Approach Using Unequal Power Allocation for Image Transmission with Chaotic Communication

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Abstract: ***The advance of wireless communication in the last few decades has led to the development of multiple transmit and receive (MIMO) systems enabling proficient real-time image and video communication. The discovery of the multiple-input multiple-output (MIMO) wireless systems shows tremendous potential to relieve the bottleneck of wireless data transmission. MIMO offers an increase in traffic capacity for future cellular systems, to face the challenge of internet-intensive applications. These advantages of multiple antenna systems along with efficient transmission and coding schemes can be explored to achieve very high data rates along with improved data reliability. This paper presents a novel approach for transmitting images over a noisy channel. The proposed method employs OFDM and chaotic encoder schemes to achieve distortion less and secure image transmission over the noisy channel.***

Keywords: **MIMO system, OFDM, chaos, unequal power allocation, distortion.**

I. INTRODUCTION

The tremendous boom in the electronics and wireless communication industry has led to on-the-move internet facility and cheaply available wireless devices. Further use of images and videos has increased the data transfer by many folds. This has set the need of efficient and reliable communication techniques with data rates. To cater to these needs recent advances in the field of wireless communications has led to some remarkable breakthroughs in the area of multiuser space-time wireless communications. MIMO communication system uses multiple antennas at both the transmitter and the receiver that creates virtual spatial sub channels, over which multiple data streams can be transmitted. Each sub channel uses the same frequency, and the transmissions occur simultaneously. In fact MIMO systems can be considered as an extension of smart antenna systems, a popular technique, dating back several decades, for improving link reliability through the use of antenna array beam forming [1]. Further even the future 4G wireless networks will combine the powerful technologies of MIMO, adaptive and reconfigurable systems (software radio) and wireless access technologies such as orthogonal frequency division multiple access (OFDMA) and multiple-carrier code division multiple access (MC-CDMA) [2].

II. LITERATURE SURVEY

Since 1990s, an ever-increasing interest has been the usage of chaotic functions to implement the encryption process. Chaotic communication is an application of chaos theory to provide secure transmission of data [3]. A chaotic system thus can be termed as a deterministic system exhibiting non-linear systems behavior with certain eminent features. Such a system employs the use of complex dynamic behavior such as pseudorandom noise and spread spectrum to encode data. Synchronization of chaotic systems and its secure communication applications have been a major research area over the last decade [4, 5]. Pecora and Carroll, in their ground-breaking work [6] have proposed a stable chaotic sub-system for constructing unidirectional coupled synchronized systems. Chaotic communication methods such as chaotic masking, chaotic shift keying [7] and those based on the projective synchronization [8] and phase synchronization [9] have also been analyzed and proposed to be secure. In [10] a secure digital communication system based on chaotic modulation, cryptography, and chaotic synchronization techniques have been proposed and analyzed numerically. In [11], a method based on encryption technique is proposed. The proposed system uses different output from chaotic transmitter, transmitted in the channel as a key stream to encrypt the message signal.

III. CHAOTIC ENCODER FORMULATION

A general chaotic system can be described by following equation:

$$x' = Ax + g(x) \qquad (1)$$

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Where Au is the linear part, g(x) is the nonlinear part of the system. For this paper we construct chaotic system by using Lorenz's chaotic system which is an autonomous 3-order nonlinear system [12] and can be represented in following states:

$x'_1 = A\,(x_2 - x_1)$ (2)

$x'_2 = c\,x_1 - x_1 x_3 - x_2$ (3)

$x'_3 = x_1 x_2 - bx_3$ (4)

Where a, b, and c are constants greater than zero and x_1, x_2, and x_3 are the dynamic states.

The input message *M* is masked by the chaotic state and transmitted. The equations of encrypt and decrypt systems are presented as following:

Encrypt side (master): $x' = Ax + g(x, v) + Lz_x$ (5)

Where $v = u_1 + M$

Decrypt side (slave): $y' = Ay + g(y, v) + Lz_y$ (6)

Where $x \in R^n$, $y \in R^n$ are the state vectors. Ax and Ay are the linear part, g(x,v) and g(y,v) are the nonlinear part of this system, L is the controller gain of the system, K>0 is the coupling strength between master and slave system, z_x and z_y are the feedback signal.

IV. PROPOSED SYSTEM

The Proposed system employs the combination of OFDM (Orthogonal Frequency Multiple Access) and Chaotic Communication. Fig. 1 below shows block diagram of the transmission section of the proposed system. The input image is first converted into bits and then these bits are given to different chaotic encoder blocks. The output of the encoders is then given to the OFDM respective transmitters section. The OFDM outputs are then transmitted using the different antennas of the MIMO system as shown in Fig. 1. At the receiver side, the receiving antennas receiver the transmitted image copies. The received bits are first given to the OFDM receiver, the output of which is given to the chaotic decoder. The mean of the outputs from the chaotic decoders is calculated the finally converted to give the final output image as in Fig. 2. Since the proposed technique uses employs a MIMO system the transmitted copies of images at different input power levels undergo different distortion through the channel. At the receiver these image copies are decoded and a mean is calculated to give the output image. This minimizes the distortion in the received image.

Initialize: k = 1, m = 1, EA = 0, MSEmin = ∞,
Δ1 = Es
M1
Step 1: Do
xk,n = Es − m(4 − k)Δk − EA,
xk+1,n = ... = x4,n = mΔk.
Find MSE(xn).
If MSE(xn)<MSEmin,
then MSEmin = MSE(xn), xmin = xk,n.
m = m + 1. While m < _ Mk
4−k _ AND
ηk,n ≥ ηk+1,n...η4,n
Step 2: xk,n = xmin, EA = EA + xk,n,
k = k + 1, m = 1, Δk = Es−EA/Mk
If k < 4 then goto Step 1,
else MSEmin

V. RESULTS

The proposed model has been implemented in MATLAB. Fig 3 below shows the input image and Figure 4 shows the output of the OFDM transmitter blocks. Fig 5 shows the BER v/s SNR graph for the proposed system. From the graph it is clear that the BER for the transmission of image in Fig 3 is of the order of 10^{-6}. Fig 6 shows the delay (in ms) graph for various SNR values. Fig 7 shows the processed input and the decoded output images. Since the BER for the image is very less the output image is exact replica of the input image. The proposed system is tested using different images and it is fund that the proposed system has very less BER as compared to simple transmission of the image through the same channel.

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Table 1 below shows the comparison of BER for transmission few standard images in Microsoft windows using the proposed method using a MIMO system and through a simple single OFDM transmitter for an SNR of 30dB. From the table its is seen that the proposed method has a better BER for the SNR value as compared to simple transmission of an image through single OFDM transmitter.

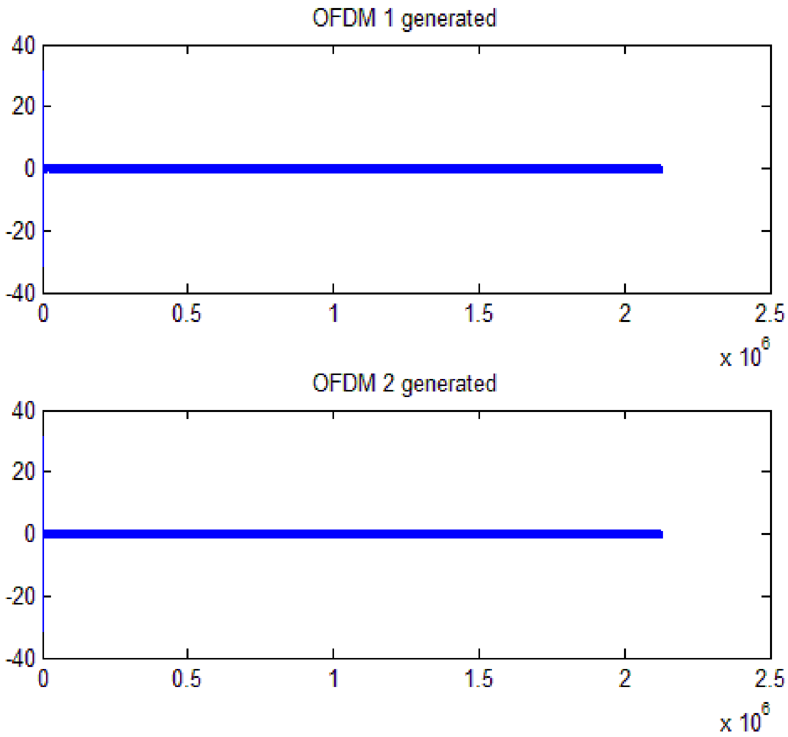

Fig 1: OFDM Transmitter output of proposed system

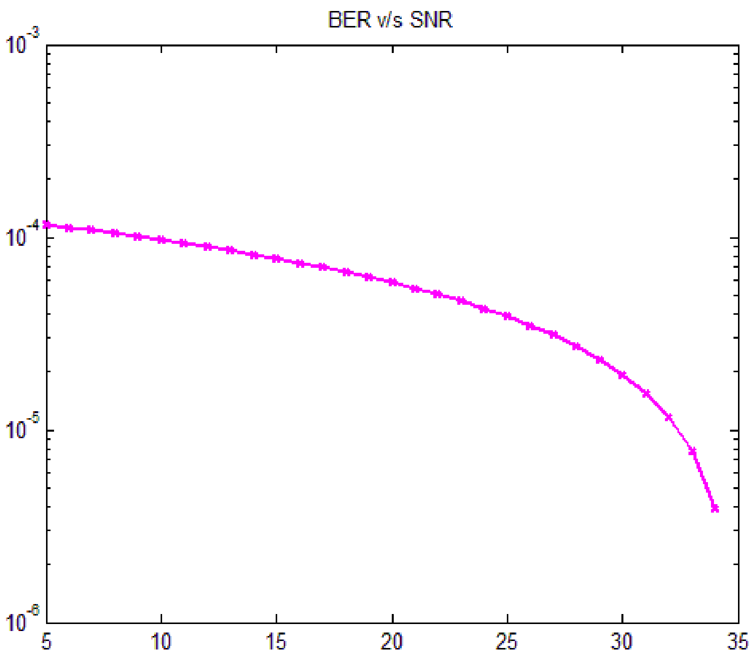

Fig 2: BER v/s SNR graph of proposed system

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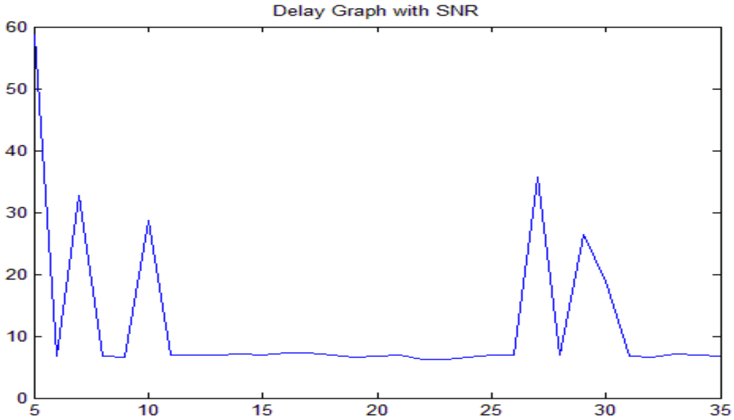

Fig 3: Delay graph

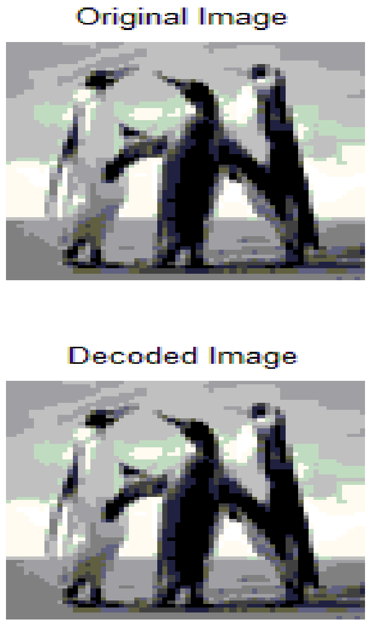

Fig 4: Processed Input and Output Images

VI. CONCLUSION

In this paper, we presented an unequal power allocation scheme for the transmission of compressed images over MIMO systems over a noisy channel. The proposed system employs OFDM and chaotic encoder schemes. The input is passed through chaotic encoder and OFDM transmitter and is transmitted using MIMO configuration. At the receiving end reverse is followed and then the mean of the received image is calculated to give the output image. The chaotic encoder ensures secure image transmission and the use of two separate transmitters reduces the channel distortion. The proposed system is tested using various images. The results show that the proposed system has less delay and less BER for a given SNR. We plan to extend this work to different video coding schemes and advanced space-time coding techniques.

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