FULL RATE STBC DESIGN IN FADDED MIMO OFDM: A Review

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***Abstract*: High power amplifiers (HPAs) are among essential parts of any wireless communication systems and HPA's nonlinearity results in constellation warping, spectrum re-growth and nonlinear inter-symbol interference (ISI), Multiple-input multiple-output (MIMO) systems, in general, when operating with nonlinear HPAs further incur nonlinear inter-channel interference (ICI). MIMO-STBC is an appropriate solution which provides the better compensation of spectrum re-growth, constellation warping, ISI and ICI. But available MIMO-STBC are not working at full rate hence proposed work will use Space Frequency Block division, SFBC provide better orthogonality instead of STBC.**

***Keywords*: High power amplifier; nonlinear distortion; phase estimation; nonlinear distortion compensation.**

I-INTRODUCTION

In current communication systems growing demand of multimedia services and the growth of Internet related contents lead to increasing interest to high speed communications. Recently, space time block codes (STBC) have gained much attention as an effective transmit diversity technique to provide reliable transmission with high peak data rates to increase the capacity of wireless communication systems. In this paper, performance of STBC-OFDM is analyzed under multipath Rayleigh fading channels with BPSK modulation, in different antenna selection techniques, and with or without PAPR reduction technique (clipping). In a multipath wireless channel environment, Multiple Input Multiple Output (MIMO) systems lead to the achievement of high data rate transmission without increasing the total transmission power or bandwidth. Multiple-Input Multiple-Output antenna systems are a form of spatial diversity. An effective and practical way to approaching the capacity of MIMO wireless channels is to employ space-time block coding in which data is coded through space and time to improve the reliability of the transmission, as redundant copies of the original data are sent over independent fading channels. Then all the signal copies are combined at the receiver in an optimal way to extract as much information from each of them as possible. In practice, wireless communications channels are time varying or frequency selective especially for broadband and mobile applications. To address these challenges, a promising combination has been exploited, namely, MIMO with Orthogonal Frequency Division Multiplexing (OFDM), MIMO-OFDM, which has already been adopted for present and future broadband communication standards such as LTE or WiMax. OFDM can reduce the effect of frequency selective channel. This is because OFDM is a multi carrier transmission technique, which divides the available spectrum into many carriers, each one being modulated by a low-rate data stream. One popular combination of MIMO and OFDM is the STBC-OFDM. STBC coding is applied across multiple OFDM blocks to enhance the system Performance inherent in MIMO-OFDM system. The coding distributes symbols along different transmit antennas and time slots. The STBC-OFDM system is one of most promising system configurations that is adopted for 4th generation mobile systems. Its advantages are the simple linear decoding and low complexity receiver which have made them a popular choice for future wireless communications. The paper is outlined as follow: In system model the STBC-OFDM is described. The effect of various factors like antenna selection techniques, rayleigh fading conditions and power conditions with clipping technique is analyzed on the STBC-OFDM system.

II. SYSTEM MODEL

Paper consider a multiple antenna wireless communication system which is equipped with 2Tx-1Rx and 2Tx-2Rx antennas .The binary input data stream is first modulated and mapped to a sequence of modulation symbols. The modulated sequence is then passed through a serial-to-parallel converter. The Alamouti scheme is then applied across two consecutive OFDM symbols. According to this coding scheme the signal copy is not only transmitted from another antenna but also at another time. At a given symbol period, two signals are simultaneously transmitted from the two antennas. In first time slot the signal transmitted from antenna first is denoted by X_k and from antenna second by X_{k+1}.

Table 1: Alamouti STBC Scheme

	Antenna 1	Antenna 2
Time t	X_k	X_{k+1}
Time t+T	$-X_{k+1}{}^*$	$X_k{}^*$

During the next time slot the signal $-X_{k+1}{}^*$is transmitted from antenna first, and signal $X_k{}^*$ is transmitted from antenna second where (*) is the complex conjugate operation as shown in table 1. So for two transmit antenna, Channel is constant during transmission for two time slots An Inverse fast Fourier Transform (IFFT) is performed on each parallel data stream. To find the corresponding time waveform an inverse fast Fourier transform is used. After the IFFT operation the received symbols are add with cyclic prefix to remove the ISI problem but on this stage the OFDM symbol have a high peak in each OFDM symbol it increase the PAPR (peak to average power ratio) this PAPR create problem when the signal pass through the HPA(high power amplifier) the noise due to HPA reduce the signal strength and make the signal corrupt to overcome this problem [1] use the PAPR reduction technique here

[1] use a clipping technique to overcome this problem. In which we clip the signal amplitude to the average level so when the signal passes through the HPA, the noise from HPA cannot increase the signal amplitude from its average value and it decrease the PAPR value. The signal is then transfer to the channel the channel have a constant value for both the time slot .after that signal reach the receiver through the multipath channel with AWGN noise.

III. MIMO STBC OFDM SYSTEM

In the MIMO STBC OFDM System with clipping technique the OFDM symbol on K^{th} carrier and l^{th} antenna is as follows

A. MIMO STBC OFDM 2Tx 1Rx antenna with clipping

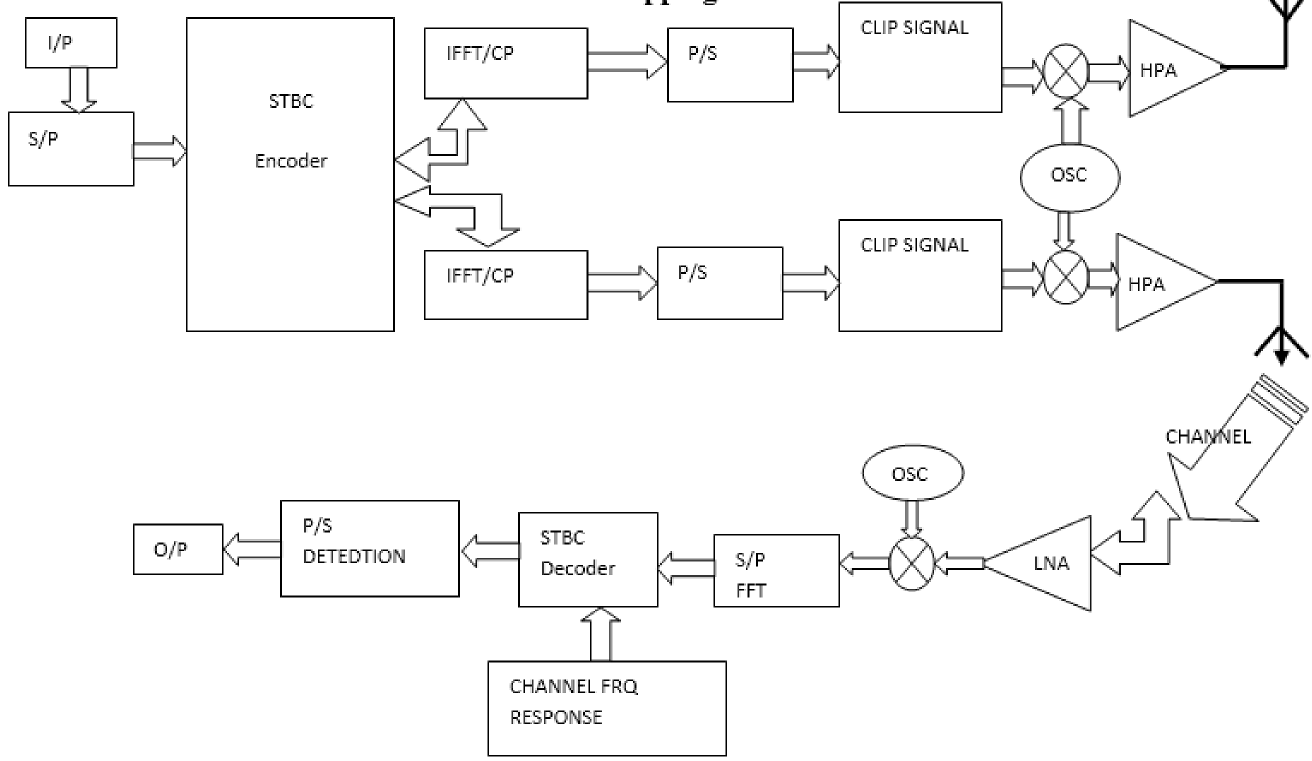

Fig .1: MIMO STBC OFDM 2Tx 1Rx Transceiver with clipping

$$x_k^l = \sum_{i=0}^{N-1} x_i e^{2\pi \frac{i}{N} k}$$

Where x_i is data symbol for i^{th} subcarrier ,each x^l_k make block of OFDM symbol of l^{th} antenna where k = 0 to N-1 and we use N carrier so length of OFDM symbol N times the period of single data symbol , after this clipping technique process is as follow

$$x_k^l(\text{clip}) = \text{avg value}, \quad \text{if } x_k^l > \text{avg value}$$

$$x_k^l(\text{clip}) = -\text{avg value}, \quad \text{if } x_k^l < -\text{avg value}$$

Non linear HPA effect on OFDM symbol in without clipping technique

$$\text{if } x_k^l > \text{avg value}$$

$$x_k^l = x_k^l + \text{noise}$$

$$\text{if } x_k^l < -\text{avg value}$$

$$x_k^l = x_k^l + \text{noise}$$

Non linear HPA effect on framed OFDM symbol in clipping technique

$$\text{if } x_k^l(\text{clip}) > \text{avg value}$$

$$x_k^l(\text{clip}) = x_k^l(\text{clip}) + \text{noise}$$

$$\text{if } x_k^l(\text{clip}) < -\text{avg value}$$

$$x_k^l(\text{clip}) = x_k^l(\text{clip}) + \text{noise}$$

In figure 1 when 2Tx and 1Rx antenna are considered, to send the data first we divide the data into k=0 to N-1 segment, each segment consist 0 to N-1 data symbol and the STBC encoding algorithm on each segment is as follows

	t_1	t_1+T
T_{x1}	X_k	$-X_{k+1}*$
T_{x2}	X_{k+1}	X_k*

After this STBC encoding we send the each encode data segment to the IFFT where it convert signal into time domain signal after IFFT $x0$,$x1$,$x2$,….$xN-1$ is OFDM symbol for each segment and these all OFDM symbol make block of first OFDM symbol that length is NTs now convert these parallel OFDM symbol to the serial these OFDM symbol after clipping send to the transmitter.
The block of OFDM symbol transmit from the antenna as follows

$T_{x1} = [\ _{0}\ \ -X_1*\ \ X_2\ \ -X_3*\ldots\ldots X_{N-1}\ ]$

$T_{x2} = [\ _{1}\ \ X_0*\ \ X_3\ \ X_2*\ \ldots\ldots\ X_{N-1}\ ]$

X_0, X_1, X_2, X_3,……,$_{-1}$ is the block of OFDM symbol

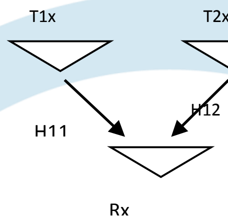

Fig .2: Channel definition in 2Tx 1Rx diversity scheme

At the receiver side the received signal at the receiving antenna R_{x1} is as follows. Where H_{11} and H_{12} channel response for T_{x1} and T_{x2} and N is the AWGN noise of channel.
R=HX+N

$$R = \begin{bmatrix} R_{t1} \\ R^*_{t1+T} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H^*_{12} & -H^*_{11} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_k \\ N^*{}_{k+1} \end{bmatrix}$$

To decode the signal on the receiver side first we compute the channel frequency response $H11$ and $H12$. Then we use the ZF equalizer to decode the OFDM data as follows.

Decoding algorithm is as follows.

$$R\wedge = \begin{bmatrix} R\wedge_{t1} \\ R\wedge_{t1+T} \end{bmatrix} = H^H R = \begin{bmatrix} H^*_{11} & H_{12} \\ H^*_{12} & -H_{11} \end{bmatrix} \begin{bmatrix} R_{t1} \\ R^*{}_{t1+T} \end{bmatrix}$$

$$\begin{bmatrix} H^2{}_{11} + H^2{}_{12} & 0 \\ 0 & H^2{}_{12} + H^2{}_{11} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix}$$

Where H^H means the conjugate transpose of H

$$\begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix} = \begin{bmatrix} H^*_{11} & H_{12} \\ H^*_{12} & -H_{11} \end{bmatrix} \begin{bmatrix} N_k \\ N^*{}_{k+1} \end{bmatrix}$$

B. MIMO STBC OFDM 2Tx 2Rx antenna with clipping: When 2Tx-2Rx antenna systems are considered, assuming the channel response for Rx1 is H_{11}, H_{12} and for Rx2 is H_{21}, H_{22} respectively

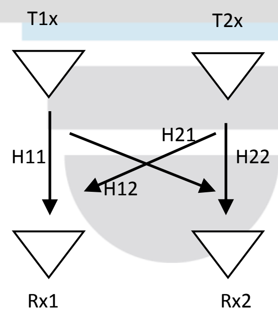

Fig .3: Channel definition in 2Tx 2Rx diversity scheme

The received signal in time domain is as follows.

$$R = \begin{bmatrix} R^1{}_{t1} \\ R^1{}_{t1+T} \\ R^2_{t1} \\ R^2_{t1+T} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H^*_{12} & -H^*_{11} \\ H_{21} & H_{22} \\ H^*_{22} & -H^*_{21} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N^1{}_k \\ N^{1*}{}_k \\ N^2{}_k \\ N^{2*}{}_{k+1} \end{bmatrix}$$

Suppose two adjacent times have same channel response then
$H^{11}{}_{t}=H^{11}{}_{t+T}$, $H^{12}{}_{t}=H^{12}{}_{t+}$, $H^{21}{}_{t}=H^{21}{}_{t+T}$, $H^{22}{}_{t}=H^{22}{}_{t+T}$
The decoding algorithm is as follows

$$R\hat{} = \begin{bmatrix} R\hat{}_{t1} \\ R\hat{}_{t1+T} \end{bmatrix} = H^H R = \begin{bmatrix} H_{11}^* & H_{12} & H_{21}^* & H_{22} \\ H_{12}^* & -H_{11} & H_{22}^* & -H_{21} \end{bmatrix} \begin{bmatrix} R^1{}_{t1} \\ R^{1*}{}_{t1+T} \\ R^2{}_{t1} \\ R^{2*}{}_{t1+T} \end{bmatrix}$$

$$\begin{bmatrix} H^2{}_{11} + H^2{}_{12} & H^2{}_{21} + H^2{}_{22} \end{bmatrix} \begin{bmatrix} X_k \\ X_{k+1} \end{bmatrix} + \begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix}$$

$$\begin{bmatrix} N_1\sim \\ N_2\sim \end{bmatrix} = \begin{bmatrix} H_{11}^* & H_{12} & H_{21}^* & H_{22} \\ H_{12}^* & -H_{11} & H_{22}^* & -H_{21} \end{bmatrix} \begin{bmatrix} N^1{}_{t1} \\ N^{1*}{}_{t1+T} \\ N^2{}_{t1} \\ N^{2*}{}_{t1+T} \end{bmatrix}$$

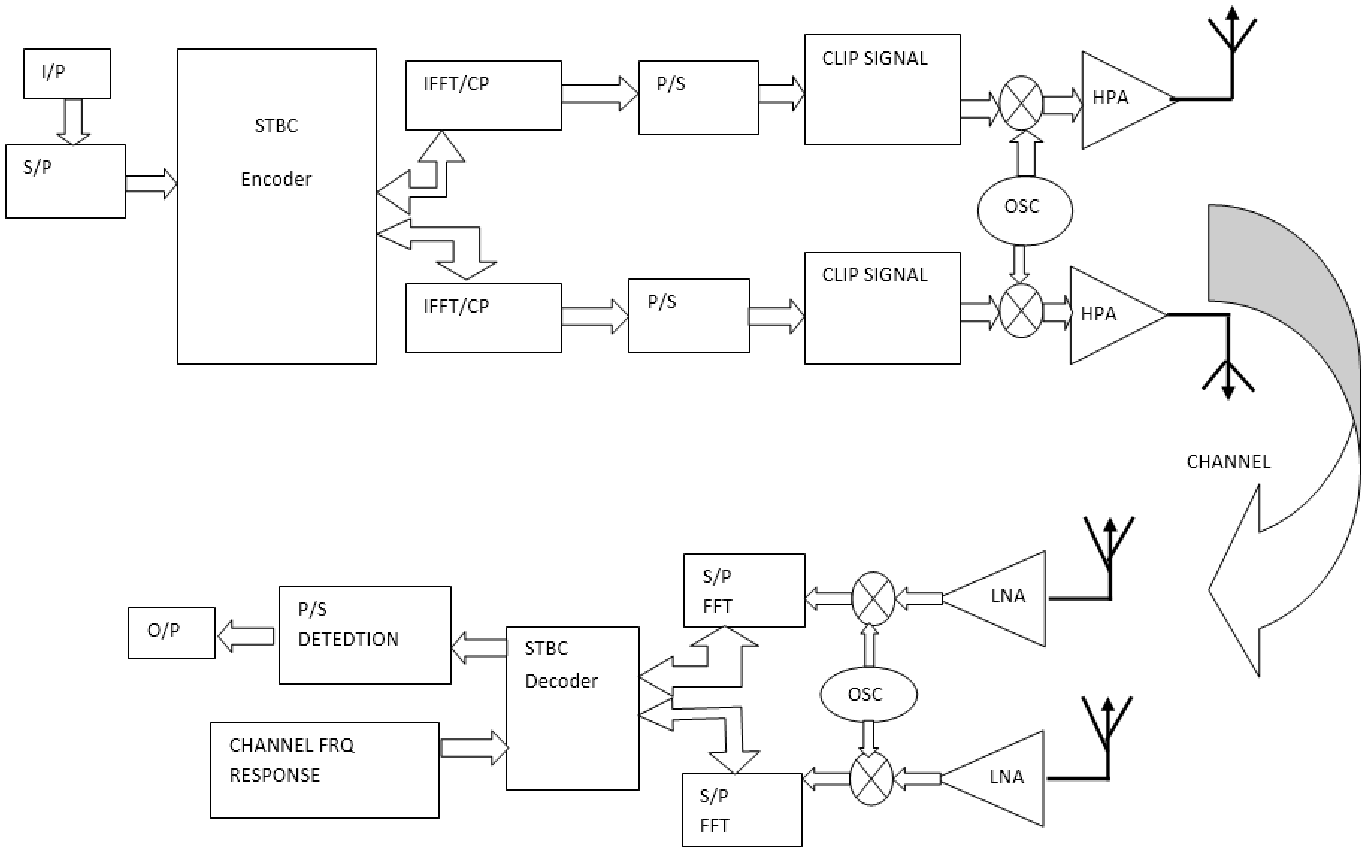

Fig 4: MIMO STBC OFDM 2Tx 2Rx Transceiver with clipping

C. OFDM 1Tx 1Rx antenna with clipping technique

When 1Tx-1Rx OFDM system considered ,assuming the channel response is H And transmitted OFDM symbol is X then they received symbol at the receiver is Y=HX

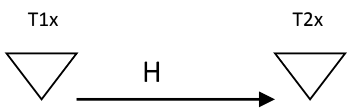

Fig 6: Channel definition in 1Tx 1Rx diversity scheme

The received signal in time domain is $R=HX+N$ where N is noise
$R/H=HX/H+N/H$

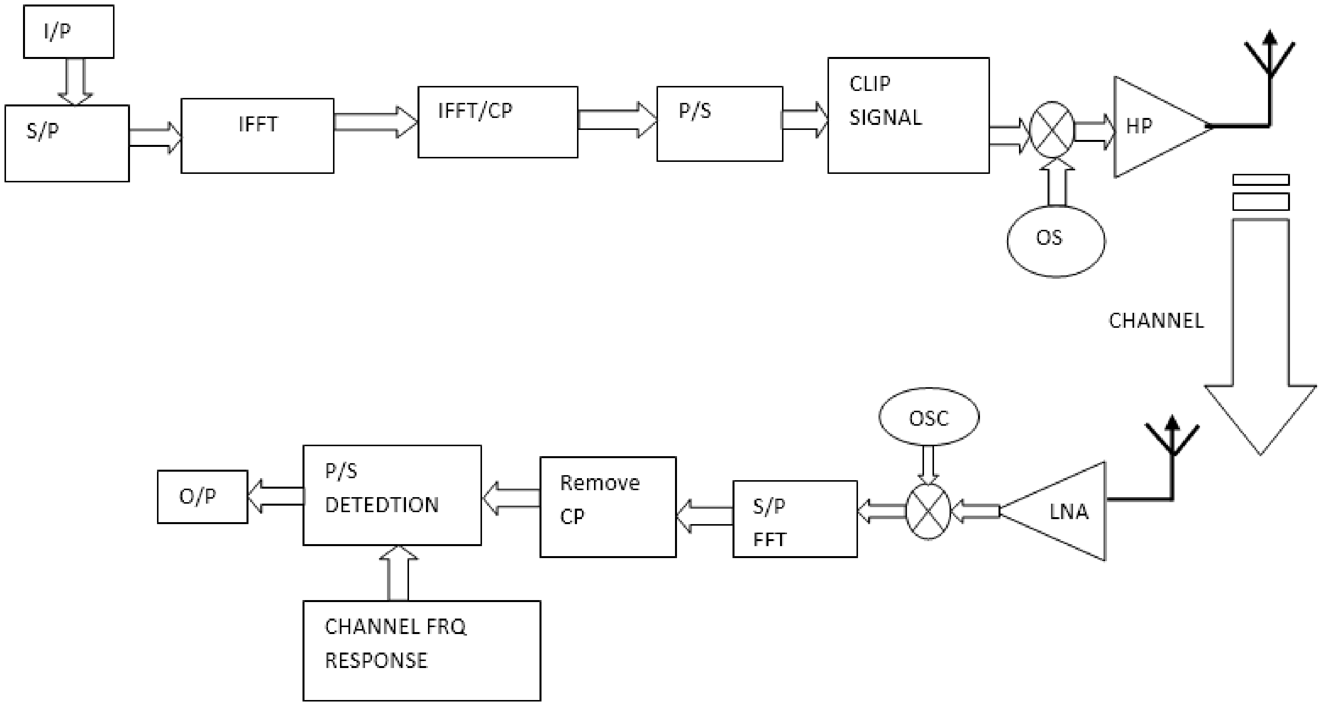

Fig.5. OFDM 1Tx 1Rx Transceiver with clipping technique

D. PAPR AND HPA: Consider the MIMO OFDM system with L transmit antennas that use N sub-carriers. In the case of two transmit antennas, the each of N-dimensional OFDM symbol is transmitted from antenna 1 and antenna 2 respectively. Generally, the PAPR of the transmitted OFDM signal is defined as:

$$\text{PAPR} = 10 \log \left(\frac{\max[x(t)x^*(t)]}{E[x(t)x^*(t)]} \right)$$

E(.) means the expectation operation. When calculating PAPR using discrete sampled signals, we cannot find the accurate PAPR because the true peak of continuous-time OFDM signal may be missed in the Nyquist sampling. So, we use 4 times over-sampling to improve accuracy of discrete PAPR. Besides, to show statistical characteristics of PAPR, we use CCDF (complementary cumulative distribution function), which is the probability that PAPR of OFDM signal exceeds a certain threshold PAPR.

IV-LITERATURE WORK

Thanh Nguyen et al[1] Based on thorough analyses of adverse effects from nonlinear distortion caused by high power amplifiers (HPAs) with phase conversion in multiple-input multiple-output space-time block code (MIMO-STBC) systems, this work proposes a nonparametric phase estimation and compensation method for the received signal. Using the optimal feed forward blind estimation technique, the receive signal's rotated phase is estimated and efficiently compensated, allowing to considerably eliminate the detrimental effect of phase distortion without any tradeoff of transmission rate. Numerical simulations verify the relevance of theoretical arguments and efficiency of the proposed compensation scheme.
In this works, effects of nonlinear distortion, especially the phase distortion, caused by HPA in the MIMO-STBC system with transmit/receive filtering are analyzed in detail. It is shown that nonlinear distortion impact in MIMO-STBC is somewhat different to what incurred in SISO system. Then, limitations and defects from previous publications are figured out. Based on the precise analysis, a phase estimation algorithm is proposed. The estimated phase is then used for the phase compensation scheme allowing vast improvements in system's performance. Since the estimation is blind with relatively short length of data sequence used, there is no loss in transmission rate, while almost simultaneously (with small delay) carrying out efficient phases compensation.

Oussama B. Belkacem et al [2] In order to provide high data rate over wireless channels and improve the system capacity, Multiple-Input Multiple-Output (MIMO) wireless communication systems exploit spatial diversity by using multiple transmit and receive antennas. Moreover, MIMO systems are equipped with High Power Amplifiers (HPA). However, HPA causes nonlinear distortions and affect the receiver's performance. Since a few decades, Neural Networks (NN) have shown excellent performance in solving complex problems like classification, recognition and approximation. In this paper, we present a receiver technique based on NN schemes for the compensation of HPA non linearization in MIMO Space-Time Block Coding (STBC) systems. Specifically, we assess the impact of HPA nonlinearity and NN on the average symbol error rate (SER) and the error vector magnitude (EVM) of MIMO-STBC in uncorrelated Rayleigh fading channels. Computer simulation results confirm the accuracy and validity of our proposed analytical approach.

III-PROBLEM STATEMENT

Multiple-input multiple-output (MIMO) systems, in general, when operating with nonlinear HPAs further incur nonlinear inter-channel interference (ICI). Specifically, for multiple input multiple-output space-time block code (MIMO-STBC) systems, the HPA's nonlinearity with phase conversion effect, rotates the receive signal and destroys orthogonality of the code. Thus, efficient countermeasures are required for diminishing such detrimental effects in such systems.

V-CONCLUSION

The presented paper provides a review of automatic phase Compensation methods used in SISO, 2x1 MIMO and 2x2 MIMO, paper also discuss problem of non linear phase shift high power amplifier due to and the solutions provided by different authors. The presented work also discussed the generalized encoding schemes for resolving the nonlinear phase shift in HPA, it can be concluded that the methods available are good enough but also need to improve the automatic phase Compensation method with good throughput and less BER.

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