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Performance of Paprin Mimo Sfbc Ci-Ofdm System

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Abstract:–One of the biggest drawbacks of OFDM is its high peak to average power ratio (PAPR). High PAPR of OFDM makes it unusable in non-linear systems. So the clipping signals scheme is one useful and simple method to reduce the PAR. This paper presents a new receive algorithm called MIMO CI-OFDM has been implemented. From the simulation results, it is shown that MIMO SFBC CI-OFDM reduces PAPR significantly compared with the conventional MIMO SFBC-OFDM system. The out-of band re-growth of signal spectrum in MIMO SFBC CI-OFDM system is much smaller than MIMO SFBC OFDM. In the NBI (narrow band interference) channel MIMO SFBC CI-OFDM system achieves considerable BER improvement.

Keywords- Orthogonal Frequency Division Multiplexing, Peak To Average Power Ratio, SFBC CI-OFDM And MIMO SFBC OFDM

I. INTRODUCTION

OFDM is a combination of modulation and multiplexing. Multiplexing generally refers to independent signals, those produced by different sources. OFDM allows the spectrum of each tone to overlap, and because they are orthogonal, they do not interfere with each other. Furthermore, the overall amount of required spectrum is reduced due to the overlapping of the tones [1].

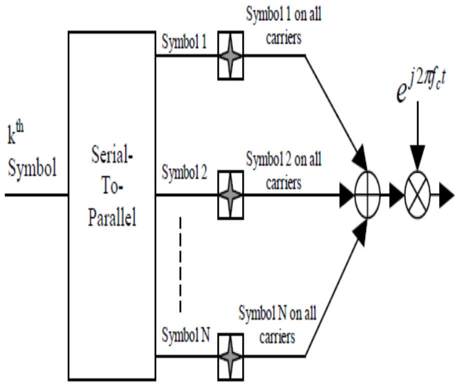
However, OFDM signal has high PAPR (peak to average power ratio) because of the superimposition of multi-carrier signals with large number of sub-carriers. The high PAPR makes the signal more sensitive to the nonlinearities of the HPA (high power amplifier) and result in signal distortion when the peak power exceeds the dynamic range of the amplifier. To transmit the high PAPR signal without distortion requires more expensive power amplifier with high linearity and wider dynamic range.

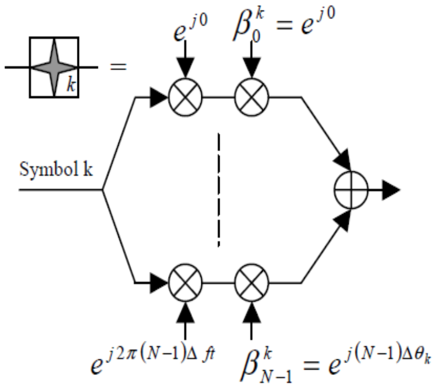
CI-OFDM (carrier interferometer orthogonal frequency division multiplexing) has been widely studied [2-5]. In the CI-OFDM technique, each information symbol is sent simultaneously over all carriers and the each carrier for the symbol is assigned a corresponding orthogonal CI spreading code. This CI/OFDM system not only can reduce PAPR problem significantly but also achieve frequency diversity gains without any loss in throughput.

In this paper is organized as follows. CI-OFDM DESCRIPTION in section II. Papr is presented in Section III. Section VI describes the simulation results. Concluding remarks are made in Section V.

II. CI-OFDM DESCRIPTION

Carrier Interferometer (CI) is a solution for reducing PAPR. This solution was first introduced in [2] as a good system solution for OFDM. Another paper followed [3] that showed that it can significantly improve the PAPR of an OFDM system. The principle behind CI is that it solves the PAPR problem without increasing the transmit bandwidth and without compromising the throughput of the system. This is achieved by transmitting each bit on all the subcarriers. This differs from the original OFDM implementation wherein after serial-to-parallel converter; each bit is allocated to its corresponding subcarrier. This can be illustrated by the Fig. 1.





(a) **Fig.1.** CI-OFDM Transmitter

In CI OFDM, information symbols are modulated onto all of the *N* parallel carriers. In order to separate symbols located on the same carrier, a phase offset known as spreading code is used. The CI spreading code for k^{th} information symbol is defined as $\beta^k = \left(e^{j0}, e^{j\Delta\theta_k}, \ldots, e^{ji\Delta\theta_k}, \ldots e^{j(N-1)\Delta\theta_k}\right)$, where $\Delta\theta_k = (2\pi / N)k$ will ensure orthogonality among the *N* information transmitted symbols which occupy the same carrier at the same time [8]. The complex baseband transmitted signals in CI OFDM is

$$s(t) = \sum_{k=0}^{N-1} s_k(t) = \sum_{k=0}^{N-1}\sum_{i=0}^{N-1} a_k e^{j\frac{2\pi}{N}ki} e^{j2\pi i\Delta ft} \qquad (0 \le t \le T_s)$$

The advantage of our design is that it is easy to employ diversity combining technique at receiver, which is necessary in fading channel environment. So, This CI OFDM system not only can reduce PAPR problem significantly but also achieve frequency diversity gains without any loss in the communication throughput.

III. PEAK TO AVERAGE POWER RATIO (PAPR)

Consider the MIMO OFDM system with *L* transmit antennas that uses *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

$$PAPR^l = \frac{\max_{0\le t\le T} \left|S^l(t)\right|^2}{E\left[\left|S^l(t)\right|^2\right]}$$

Where *l* means the transmit antenna number and *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/CIOFDM signal exceeds a certain threshold $PAPR_0$. The CCDF is defined as

$$\begin{aligned} CCDF^l &= \Pr\left(PAPR^l > PAPR_0\right) \\ &= 1 - \Pr\left(PAPR^l \le PAPR_0\right) \\ &= 1 - \prod_{n=1}^{N}\left[1 - \exp\left(-PAPR_0 \times \frac{P_{avg}^l}{P_n^l}\right)\right] \\ &= 1 - \left(1 - \exp\left(-PAPR_0\right)\right)^{\alpha N} \end{aligned}$$

where P_n^l is the average sample power of l^{th} transmit antenna signal, $P_{avg}^l = (1/T)\int_0^T \left|S^l(t)\right|^2 dt$ is the average power of l^{th} transmit antenna signal, here, when oversampling is done, $P_n^l = P_{avg}^l$ is nearly satisfied. Commonly, α is 2.8 in most cases.We define the observed CCDF of MIMO transmitter is

$$CCDF = \max_{0<l\leq L}\left(CCDF^{\,l}\right)$$

IV. SIMULATION RESULTS

Based on the above theoretical analysis, in order to compare the transmission performance both in the MIMO SFBC OFDM and MIMO SFBC CI-OFDM system, we evaluated the PAPR, Spectrum and BER of MIMO SFBC OFDM and MIMO SFBC CI-OFDM when SSPA is used as each transmitter’s HPA or/and NBI is inserted to the data carriers. 2Tx-1Rx and 2Tx-2Rx MIMO scheme is considered. HPA back off values are supposed to be 2, 3 and 6. JSR (or ISR) of NBI is supposed to be 0dB or 1dB. AWGN and Rayleigh fading channels are considered through the whole evaluation. The total sub carrier number is supposed to be 1024 and 16QAM modulation is used in the whole simulation

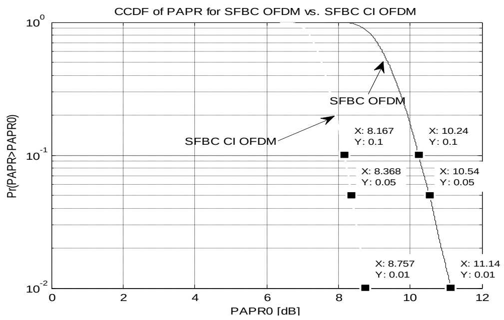


Fig.2: PAPR in MIMO SFBC OFDM & CI OFDM

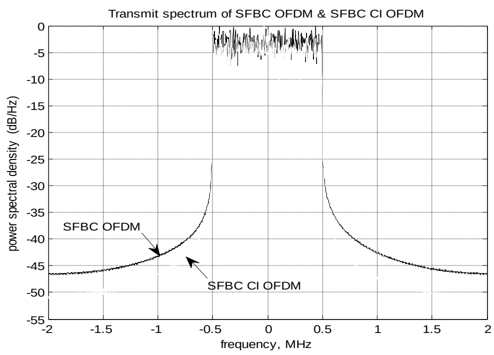


Fig.3: Spectrum in MIMO SFBC OFDM & CI OFDM

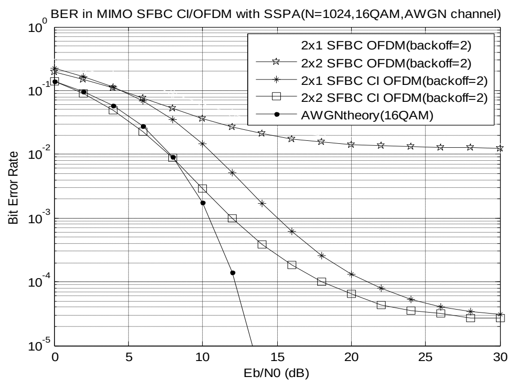


Fig.4*:* BER in MIMO SFBC OFDM & CI OFDM with HPA (back off=2)

V. CONCLUSION

We evaluated the performance of MIMO SFBC OFDM and MIMO SFBC CI OFDM system on the basis of MIMO technique, and focused on the two Tx/one Rx antenna and two Tx/two Rx antenna configurations under both AWGN and Rayleigh fading channel. SFBC coding is applied in both MIMO OFDM system and MIMO CI-OFDM system.Overall, MIMO SFBC CI-OFDM system outperforms MIMO SFBC OFDM significantly when system is interrupted by the HPA nonlinearity or NBI under both AWGN and Rayleigh fading channel. Therefore, the MIMO SFBC CI OFDM method can be further applicable to the any kinds of MIMO type multi-carrier communication systems with many sub-carriers.

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