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Space-Time Block Code in MIMO-OFDM Cyclic Prefix Cancellation Schemes for Mitigating ICI

L Rajeshwar Reddy
Department of Electronics & Communication Engineering,
Vignana Bharathi institute of Technology,
Hyderabad, T.S, India- 501301.

Belcy D Mathews
Department of Electronics & Communication Engineering,
Vignana Bharathi institute of Technology,
Hyderabad, T.S, India- 501301.

Abstract

Based on the orthogonality of space-time (ST) code, this paper focuses on ST code transmission joined with intercarrier obstruction (ICI) parallel cancelation (PC) plan to shape STPC frameworks. With known channel state data (CSI) and orthogonal recurrence division multiplexing (OFDM), we additionally build up this STPC-OFDM framework with code rates 1 and 0.5 without expanding in power, transmission capacity, and computational load for OFDM get to (OFDMA) downlink from base station (BS) to versatile unit (MU) terminals. Recreation comes about demonstrate that this 4 × 1 STPC-OFDM framework with code rate 1 gives extraordinary piece mistake rate (BER) execution than that of the regular 4 × 1 ST square coded OFDM frameworks with code rate 0.5 in COST 207 moderate (normal urban) and quick (awful urban) recurrence specific blurring channels. Besides, this STPC-OFDM can be utilized as the major building hinder for ST-MIMO-OFDM frameworks.

Index Terms— Inter-carrier interference (ICI), Parallelcancellation, frequency offset, Space time (ST), MIMO, OFDM.

I. INTRODUCTION

These days, the mix of the correspondence frameworks between Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input Multiple Output (MIMO) has pulled in both scholarly community and industry consideration in view of the developing requirement for high information rate correspondence and better nature of administration. Nonetheless, transporter recurrence counterbalance and time varieties because of Doppler move cause lost the orthogonality among subcarriers at the collector and results in between bearer impedance (ICI) which debases the bit blunder rate (BER) execution of OFDM frameworks perceptibly. From one viewpoint, many plans to moderate the ICI in OFDM frameworks, for example, parallel cancelation (PC) [1], conjugate cancelation (CC) [2], mid-point look calculation [3], self-cancelation (SC) [4] are produced. Then again, a lot of novel developments in light of the space-time piece code (STBC) to give better transmitter decent variety and coding pick up [5-7] are created, however few of them performed both the assorted variety and the ICI relief together. With known channel state data (CSI) at the recipient, we propose another plan that incorporates both ST-OFDM and PC standards to frame a MIMO STPC-OFDM framework with code rates 1 and 0.5 for OFDMA downlink from the base station (BS) to portable unit (MU) terminals. This new plan not just gives the assorted variety for transmission, including space-time (ST) coding pick up, yet additionally assumes a part in moderating ICI by means of PC plot in versatile Doppler blurring diverts at the same time without expanding in power, transfer speed, and many-sided quality [1]. Note that in SC [4], it utilizes information redundancy inside one OFDM hinder at the subcarrier level. It is a not reasonable to shape ST-SC conspire. Then again, PC works at the OFDM image level. It is consistently joined with ST. Since the examination of the general two-way transmission for ICI diminishment in OFDM frameworks was displayed in [8], and the ST idea with ICI cancelation in [9], we concentrate on the framework outline and BER execution correlation of the MIMO STPCOFDM frameworks with code rates 1 and 0.5 by

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means of re-enactments in recurrence particular versatile blurring channels for 2 and 4 transmit receiving antennas.

II. OFDM SYSTEMS AND PC SCHEME

A. OFDM systems

The complex baseband OFDM transmitted signal *k x* at the
output of the IFFT is

$$X_{k=\sum_{n=0}^{N-1} d_n e^{j\frac{2\pi}{N}kn}} \qquad k=0,1,2,3.......,N-1$$

where *n d* is the data symbol, andrepresents the corresponding orthogonal frequencies of *N*subcarriers. At the receiver, the received signal is mixed witha local oscillator signal, which is above the correct carrierfrequency with a phase offset, plus the additive white Gaussiannoise (AWGN). Without loss of generality, both the AWGNand phase offset are set to zero in this paper for simplicity. Thebaseband recovered signal after FFT is

$$\widehat{d_m} = \frac{1}{N}\sum_{k=0}^{N-1} r_k\, e^{-j\frac{2\pi mk}{N}}$$

$$= \frac{1}{N}\sum_{n=0}^{N-1}\sum_{k=0}^{N-1} d_n H_n e^{j\frac{2\pi(n+\varepsilon)k}{N}} e^{-j\frac{2\pi mk}{N}}$$

$$= H_m u_0 d_m + \sum_{n=0, n\neq m}^{N-1} H_n u_{n-m} d_n \qquad m=0,......$$

where

$$u_{n-m} = \frac{e^{j\pi\frac{N-1}{N}} \sin\left[\pi(n-m+\varepsilon)\right]}{N.\sin\left[\left(\frac{\pi}{N}\right).(n-m+\varepsilon)\right]} \Bigg| \text{(n-m)mod}$$

K is sampling index of the received signal at the sampling instants. *n H* is the *n*thelement of the *N*-point FFT of the channel impulse response *h*, and *n m u* □ is the weighting factor on the data symbol, € is the normalized frequency offset to the subcarrierfrequency spacing; *m* is the receiver subcarrier index.the first term represents the desired signal component. Thesecond term represents the ICI components due to frequencyoffset €. Note that *n m u* in n,m represents the weightingfactor on the data symbol in the regular OFDM system.

B. The PC scheme

The PC scheme [1] has a two-branch operation as depictedin Fig. 1 to mitigate ICI. At the transmitter, the first branchworks as the regular OFDM system transmitted with serial-toparallel(S/P), cyclic prefix (CP), and parallel-to-serial (P/S)operations. Independently, the 2nd branch employs an FFT atthe transmitter as defined:

$$x_k = \sum_{n=0}^{N-1} d_n e^{-j\frac{2\pi}{N}km} \qquad k=0,1,2,3,......,N-1$$

At the receiver, a de-multiplexing operation to separate twotransmitted signals and CP removal (CPR) are performed first;the first branch works as the regular OFDM receiver, the 2[nd]branch requires an IFFT for the signal as follows:

$$\hat{d}_m = \frac{1}{N}\sum_{k=0}^{N-1} \grave{r}_k\, e^{j\frac{2\pi mk}{N}}$$

$$\frac{1}{N}\sum_{n=0}^{N-1}\sum_{k=0}^{N-1} d_n \bar{H}_n e^{j\frac{2\pi(-n+\varepsilon)k}{N}} e^{\frac{2\pi mk}{N}}$$

$$\bar{H}_m v_0 d_m + \sum_{n=0, n\neq}^{N-1} \bar{H}_n v_{n-m} d_n \qquad m=0,.....$$

The PC-OFDM system is a simple transmit diversityschemethat improves the signal quality at thereceiver by simplyprocessing across two transmission time slots consecutively.The obtained diversity order is equal to two. This PC-OFDMscheme shows the outstanding performance dealing with ICIcancellation in fading channels [1].

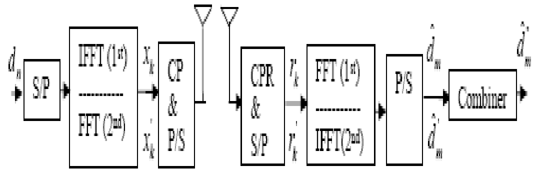

Fig. 1. The simplified PC-OFDM transceiver.

III. 2X1 STPC-OFDM SCHEME:

The standard ST-OFDM framework [9] applies the ST transmitter decent variety system in a for each OFDM image premise.

We make the documentations for the factors, for example, channel motivation reactions, got signals, with a few sub indexes for MIMO frameworks as takes after. For instance, ijh , has two sub indexes and ijt y has three sub indexes. The main subindex speaks to the get radio wire list "I" while the second subindex speaks to the transmit recieving wire list "j" and the third subindex on ijt y speaks to the schedule opening of the ST code.

In a 2-transmit framework, two length N back to back pieces are shaped as information vectors at the transmitter as takes after:

Orthogonal Frequency Division Multiplexing (OFDM) is a system in which the aggregate transmission data transfer capacity is part into various orthogonal subcarriers with the goal that a wideband flag is changed in a parallel game plan of narrowband „orthogonal" signals. Thusly, a high information rate stream that would some way or another require a channel data transmission a long ways past the real intelligence transfer speed can be isolated into various lower rate streams. Expanding the quantity of subcarriers builds the image time frame so that, in a perfect world, a recurrence specific blurring channel is transformed into a level blurring one. As it were, OFDM handles recurrence particular blurring coming about because of time scattering of multipath channels by growing the image length [1].

High information rates are subsequently conceivable and therefore it has been picked as the transmission strategy for some norms from link based Asymmetric Digital Subscriber Line (ADSL), to remote frameworks, for example, the IEEE 802.11a/g neighborhood, the IEEE 802.16 for broadband metropolitan region arrange and computerized video and sound telecom. The way that the OFDM image period is longer than in single bearer balance, guarantees a more prominent heartiness against Inter-Symbol Interference (ISI) caused by postpone spread. Then again, this makes the framework more delicate to time varieties that may cause the loss of orthogonality among subcarriers therefore presenting cross obstruction among subcarriers. Other conceivable reasons for this misfortune might be because of recurrence or testing counterbalances developing at the nearby oscillator, stage clamour and synchronization mistakes: the blend of every one of these elements frames the recurrence area OFDM channel reaction that can be outlined in an ICI framework. Estimation of this channel network is urgent to augment execution, however in genuine OFDM frameworks this undertaking can be extremely intense, since the extent of the ICI grid relies upon the quantity of OFDM subcarriers which can be in the request of hundreds or thousands. A few channel estimation calculations and strategies to get ICI cancelation have been accounted for in the writing in both recurrence and time area: albeit daze procedures are conceivable without decrease of Spectrum productivity, business frameworks incorporate pilot examples to enhance the estimation procedure.

These are misused for instance in [2] where a pilot-image helped estimation in the time space is proposed.

Different methodologies tend to abuse some other repetition in the flag structure. In [3][4], preparing images are utilized to evaluate the recurrence counterbalance, in [5] the creators propose to utilize the cyclic-prefix and afterward Independent Component Analysis (ICA) is connected to the gotten subcarriers. In [6] recurrence counterbalance estimation is acquired by rehashed data images.

where

$$v_{n-m} = \frac{e^{j\pi\frac{N-1}{N}(m-n+\epsilon)}\sin[\pi(m-n+\epsilon)]}{N.\sin[\left(\frac{\pi}{N}\right).(m-n+\varepsilon)]}\Bigg| \text{(n-m)modN}$$

V. PROPOSED MIMO-STPC-OFDM SCHEMES

In this Section, MIMO-STPC-OFDM systems are proposed asdepicted in Fig. 4. The 2x1 STPC scheme is employed as thefundamental building block in Fig. 4, specifically in the receiverside. Hence, there are 2 transmit antennas and *i*-pair receiverantennas. The coherent combiner is performed at the last (mostright) stage to improve the BER performance.

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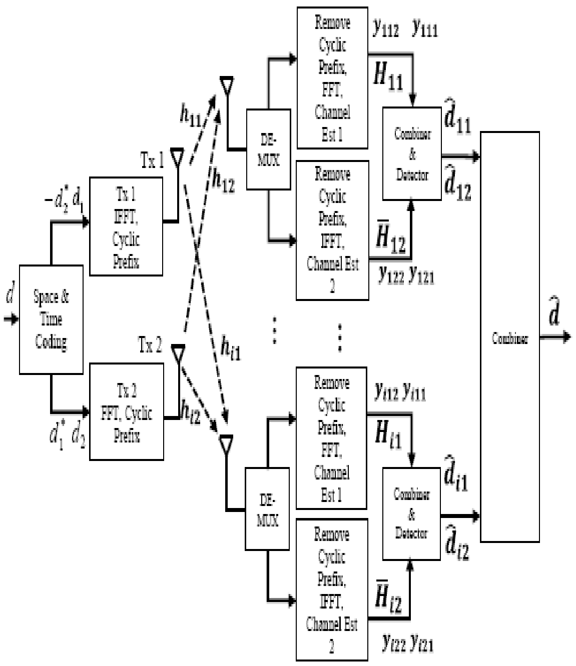

Fig. 2. Block diagram of the MIMO-STPC-OFDM system.

IV. SIMULATION RESULTS

Reproductions are directed to survey the BER execution of the ST-OFDM and STPC-OFDM plans with various coding rates and diverse number of transmission radio wires. The COST207 channel models are utilized. These 6-beam regular urban (TU) and terrible urban (BU) speak to moderate and quick recurrence particular versatile channels, separately. All reproductions are performed at an image rate of 220 images/second, an OFDM piece size of N=256, and an examining time of Ts = 2-20 sec. A fourth of N tests are utilized as the cyclic prefix. QPSK regulation is connected to all reproductions. It is expected that the channel reactions, h1 and h2 for 2x1

ST and STPC frameworks, and h1, h2, h3, and h4 for 4x1 ST and STPC frameworks. They are assessed at the beneficiary and remain constants for two and four-schedule openings for 2x1 and 4x1 ST and STPC frameworks with code rate 1, individually, and remain constants for eight-availabilities for 4x1 ST and STPC frameworks with code rate 0.5, separately.

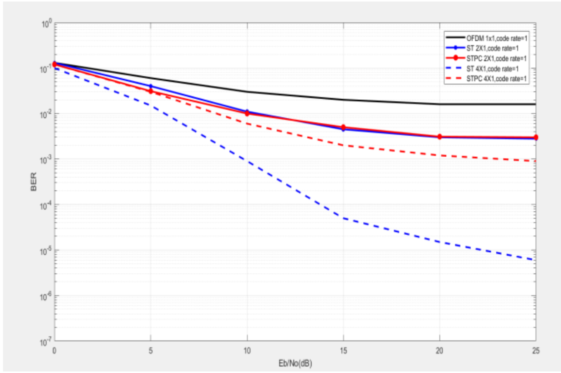

Fig. 3. BER comparison of regular OFDM, ST-OFDM, STPC-OFDM for 2x1and 4x1 respectively using code rate 1 in TU channels with maximum Dopplerfrequency Fmax= 200 Hz.

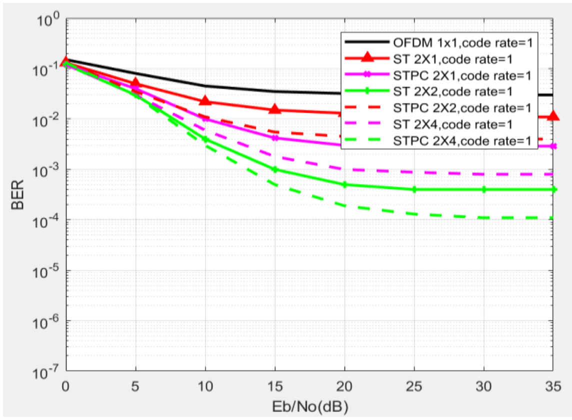

Fig. 4. BER comparison of regular OFDM, ST-OFDM, STPC-OFDM for 2x1,2x2 and 2x4 respectively using code rate 1 in TU channels with maximumDoppler frequency 300 Hz.

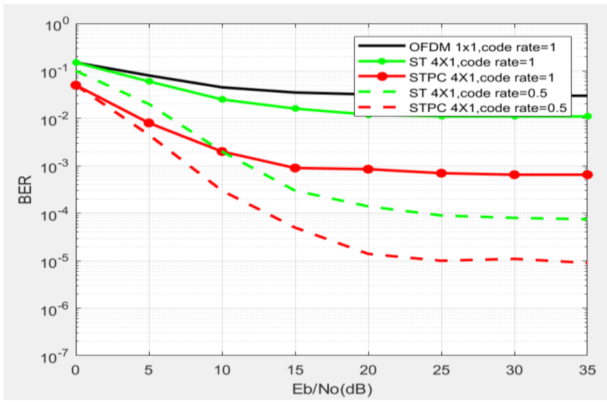

Fig. 5. BER comparison of 4x1 ST-OFDM and STPC-OFDM for coding rate 1and 0.5 in TU channels with Fmax= 300Hz.

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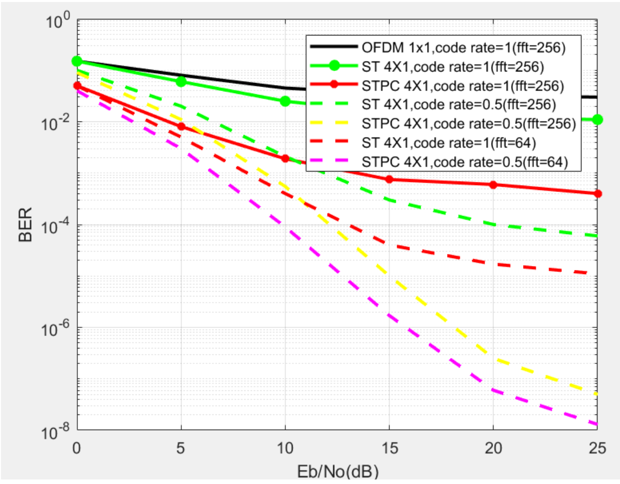

Fig. 6. BER comparison of 4x1 ST-OFDM, STPC-OFDM for coding rate 1 and0.5 with different FFT sizes in BU channels,Fmax= 300 Hz.

VI. CONCLUSION

This paper investigates the extension of STPC-OFDM method from 2x1 to 4x1 frameworks with code rates 1 and 0.5 for OFDM get to (OFDMA) downlink from BS to MU terminals. It is discovered that a 4x1 STPC-OFDM framework with rate 1 gives remarkable BER execution than the traditional 4x1 STOFDM frameworks with rate 0.5 in COST 207 moderate TU and quick BU recurrence specific blurring channels when Eb/N0 > 10 dB. The MIMO-STPC-OFDM plot isn't just keeping topping quality from both the ST (hearty to OFDM image size) and PC (ICI cancelation) plans, yet in addition outflanks the straightforward MIMO-ST-OFDM conspire in versatile directs without expanding in power, transfer speed, and framework unpredictability. All the more significantly, it demonstrates the strength on higher Doppler recurrence, which definitely meets the pattern of the developing requirement for high information rate correspondence and better nature of administration in portable interchanges. Assorted variety pick up is likewise be abused by this MIMO-STPC-OFDM handset, which requires just straightforward direct handling on the collector side for deciphering. Moreover, the reproduction has demonstrated the significance of the unpredictable orthogonality of ST code grid. More particular, through diminishing coding rate traded off the orthogonality, we found the BER execution is likewise showing signs of improvement. Along these lines, joining the orthogonality utilizing the orthogonal transmission grids with other ICI cancelation plans will be a piece of the further research.

REFERENCES

[1] H. G. Yeh and K. Yao, “A parallel ICI cancellation technique for OFDMsystems,” in IEEE Global Commun. Conf., 2012, pp.3679-3684.

[2] H. G. Yeh, Y.K. Chang, and B. Hassibi, “A scheme for cancelling intercarrier interference through conjugate transmission for multicarriercommunication systems,” IEEE Tran. on Wireless Commun., vol. 6, no.1, Jan. 2007, pp. 3-7.

[3] C. C. Chen, J.M. Wu, and Y.J. Wu, “A low-complexity ICI mitigationmethod based on generalized data-allocation for OFDM systems,” in 11th IEEE International Conf. on Commun. Technology, 2008, pp. 194-197.

[4] Y. Zhao and S-G. Haggman, “Intercarrier interference self-cancellationscheme for OFDM mobile communication systems,” IEEE Trans.Commun., vol. 49, no. 7, July 2001, pp. 1185-1191.

[5] I. Choi, J. K. Kim, H. Lee, and I. Lee, “Alamouti-codes based fourantennatransmission schemes with phase feedback,” on IEEE Commun.Letters, vol. 13, no. 10, Oct. 2009, pp. 749-751.

[6] F. Hu, L.B. Jin, J.Z. Li, and J.W. Ji, “Novel constructions of MIMOSTBC designs employing four transmit antennas,” in IEEE InternationalConf. on Industrial Control and Electronics Engineering, 2012, pp.1269-1272.

[7] B. Tao, J.D. Xu, and H.S. Zhang, “High-rate low-delay complexorthogonal space-time block codes for eight transmit antennas,” in IEEENinth International Conf. on Electronic Measurement and Instruments,2009, pp. 3-174-3-177.

[8] M. Wen, et al., “Two-path transmission framework for ICI reduction inOFDM systems,” in Proc. of 2013 IEEE GlobeCom, Atlanta, GA, Dec.2013, pp. 3716 – 3721.

[9] Taiwen Tang; Heath, R.W., "Space-time interference cancellation inMIMO-OFDM systems," in Vehicular Technology, IEEE Transactionson ,vol.54, no.5, pp.1802-1816, Sept. 2005.

[10] S. M. Alamouti, “A simple transmit diversity technique for wirelesscommunications,” IEEE Journal on Select Areas in Commun.., vol. 16,no. 8, Oct. 1998, pp. 1451-1458.

[11] Tarokh, Vahid; Jafarkhani, Hamid; Calderbank, A.R., "Space-time blockcodes from orthogonal designs," in Information Theory, IEEE
Transactions on ,vol.45, no.5, pp.1456-1467, Jul 1999.

[12] Su, W.; Xiang-Gen Xia, "Signal constellations for quasi-orthogonal space-time block codes with full diversity," in Information Theory, IEEETransactions on , vol.50, no.10, pp.2331-2347, Oct. 2004.