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Downlink Precoding Methods for Multi-user Multiple Input-Multiple Output (MU-MIMO)

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Abstract:
Multi user multiple input multiple output (MU-MIMO) strategy turns out to be most mainstream in business sector of remote correspondence, for example, 4G system, Wi-Max and so on which needs throughput to transmit and get several megabits for each second.MU-MIMO turns out to be more prevalent to work for downlink on broadcast channel(BC) for communicate transmissions. In this one transmitter or base station (BS) which is having various radio wires need to transmit distinctive and autonomous messages or information or data by means of BC to every client all the while. Furthermore, that perceives multiuser interference (MUI) in BC transmission. So for disposal of MUI pre coder ought to be favored with better pre coding plan. There are some pre coding plans to be required for the disposal of multi client impedance (MUI), diminish SNR and enhance BER rate, which are described in two classes. From them in direct pre coding, Block diagonalization (BD) and Minimum mean square error pre coding (MMSE) and zero compelling (ZF), and in Non Linear pre coding, Tomlinson Harashima Pre coding (THP) and Dirty Paper Coding (DPC) systems are utilized .In this paper we thought about all straight and non-straight procedures on bases of SNR and BER.

Keywords: Downlink Precoding Techniques, Zero Forcing (ZF), Minimum mean-square-error (MMSE), Block Diagonalization (BD), Tomlinson-Harashima Precoding (THP), Dirty Paper Coding (DPC).

I. INTRODUCTION

In late earlier years, there has been a significant enthusiasm for remote various info, numerous yield (MIMO) correspondence frameworks in light of their promising improvement as far as execution and data transmission proficiency [1]. An imperative exploration theme is the investigation of Multi-client Multiple Input-Multiple Output (MU-MIMO) frameworks [3]. Such frameworks can possibly join the high throughput achievable with Multiple Input-Multiple Output (MIMO) preparing with the advantages of SDMA (Space Division Multiple Access) [3]. In the downlink situation, a base station (BS) is furnished with numerous reception apparatuses and it is simultaneously transmitting to an accumulation of clients. Each of these clients is additionally furnished with various reception apparatuses. Here, the base station can arrange the transmission from the greater part of its receiving wires. The getting reception apparatuses are aligned with uncommon clients that are regularly not able to organize with each other. The BS misuses the CSI (channel state data) realistic at the transmitter to permit these clients to have the same channel and reduce or in a perfect world totally kill multi-client impedance (MUI) by pillar framing (straight pre-coding) generally by the use of filthy paper codes [9]. It is key to have CSI at the base station since it permits joint preparing of each client's signs which result in a critical execution change and expanded information rates. All pre-coding procedures can be ordered taking into account whether they permit MUI (as zero or non-zero MUI systems) and by their linearity (as non-straight and direct techniques). Direct precoding systems require no overhead to give the portable the demodulation data and are with a decrease of computationally costly than their non-straight partners However, non-straight procedures give a much higher limit.

II. LINEAR PRECODING TECHNIQUES

A. Zero Forcing Filter (ZF)

Since the base station has no influence on the commotion at the client terminals, the most natural methodology for pre-coding is a zero constraining channel (ZF) which dispenses with all meddling at the client terminals. Expecting single radio wire terminals, the translating grid gets to be G=Ik and MR=K. Give us a chance to characterize the Precoding grid F as F=βFa

The Precoding network Fa and the scaling element β result from the accompanying advancement.

$$F_a = \arg\min E\,\{||HF_a x - x||2\} \text{ such that } HF_a = I_k \text{ -- (1)}$$

In the same as the unraveling ZF channel, the transmit ZF channel likewise experiences the commotion expansion issue and required increment in transmit power. It is problematic and brings about huge presentation debasement.

B. Minimum mean-square-error (MMSE)

This pre-coding enhances the framework execution by permitting a positive measure of obstruction especially for clients furnished with a solitary recieving wire. Be that as it may, it endures an execution misfortune when it endeavors to direct the obstruction between two firmly separated reception apparatuses, circumstance continually happening when the client terminal is set up with development than one get radio wire. The ZF pre-coder totally wipes out the multiuser crossing point at the expense of commotion enlargement. The base mean square blunder (MMSE) pre-coder adjusts the multiuser interface facilitating with commotion expansion and minimizes the aggregate mistake so contrast with ZF pre-coder, the MMSE pre-coder can't plan direct [10].

C. Block Diagonalization (BD)

It is a straight pre-coding procedure for the downlink of MU MIMO frameworks [2,7]. It deteriorates a MU MIMO downlink channel into various parallel orthogonal single-client MIMO channels [4, 6]. The sign of every one client is pre-prepared at the transmitter utilizing a tweak grid that lies in the invalid space of each one further clients channel networks. By this implies the MUI in the framework is productively set to zero. BD is alluring if the clients are prepared through other than one radio wire. Be that as it may, the zero MUI requirement can prompt an extensive limit misfortune when the clients' subspaces essentially cover.

III. NON-LINEAR PRECODING TECHNIQUES

It is outstanding that straight evening out experiences clamor enlargement and thus has poor force effectiveness sometimes. The same disadvantage is experienced through straight precoding, which battles commotion by boosting the transmit power. This inconvenience of straight evening out at the collector side can be stayed away from by Non-direct precoding systems.

A. Tomlinson-Harashima Precoding (THP)

It is a non-straight pre-coding created for single-info, single-out-put (SISO) multipath channels. THP can be deciphered as influencing the criticism segment of the DFE to the transmitter. As of late it has been additionally valuable for the pre-adjustment of MUI in MIMO frameworks [1], where it perform spatial pre-evening out rather than transient pre-balance for ISI channels. In that way no mistake engendering happen. Thusly the pre-coding can be performed for the obstruction free channel [8].

MMSE pre-coding in course of action with THP is anticipated in MMSE equalizations the MUI keeping in mind the end goal to lessen the execution misfortune that happens with zero meddling technique however THP is utilized to facilitate the MUI and to enhance the differing qualities [5, 10].

SO-THP proposed in joins SO and THP in sort to lessen the limit misfortune because of the cancelation of covering subspaces of assorted clients and to nullify the MUI [4]. After the pre-coding, the subsequent proportionate consolidated channel network of all clients is again square corner to corner. This likewise encourage the clarity of another requesting calculation. This techniques permits more than one reception apparatus at the portable terminal and has no standard misfortune because of the cancelation of impedance between the signs transmitted to two entirely separated radio wires at the same terminal.

B. Dirty Paper Coding (DPC)

The idea of writing on grimy paper‖ was presented by Costa. Dirty paper coding (DPC) over the span of inferring the channel limit of communicate channel (BC) demonstrating that an obstruction free transmission can be acknowledged by subtracting the potential impedance before transmission. In principle, DPC would be actualized when channel increases are totally known on the transmitter side. DPC is a strategy for pre-coding the information with the end goal that the impact of the impedance can be drop subject to the some obstruction that is known not transmitter. All the more exactly, the impedances because of the first up to (k-1) th someone who is addicted signs are scratched off over the span of pre-coding the kth client signal. To streamline this, we consider the instance of NB=3, K=3 and NM,u=1, u=1,2,3. on the off chance that the u th client sign is given by Xu Ɛ C , then the got sign is given as:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} H_1^{DL} \\ H_2^{DL} \\ H_3^{DL} \end{bmatrix} \begin{bmatrix} \tilde{X}_1 \\ \tilde{X}_2 \\ \tilde{X}_3 \end{bmatrix} + \begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \end{bmatrix}$$

Where,

$H_u^{DL} = \in C^{1\times 3}$, is the channel gain between BS and the u th user. The channel matrix H_{DL} can be LQ- decomposed as,

$$H_{DL} = \begin{bmatrix} l_{11} & 0 & 0 \\ l_{21} & l_{22} & 0 \\ l_{31} & l_{32} & l_{33} \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix}$$

L **Q**

Therefore on the downlink the base station will use any channel state information available to mitigate or ideally completely eliminate multi-user interference through linear or nonlinear (DPC or THP) pre-coding, which leads to significant information rate gains. The user terminal estimates the effective channel and transmits data in the next uplink frame.

IV. SIMULATION RESULTS

In this section, we will compare the performance of Linear pre-coding like Zero forcing (ZF), Minimum mean-square-error MMSE and Block diagonalization (BD), and also non linear pre-coding like dirty paper coding (DPC) and Tomlinson-harasimha pre-coding (THP).

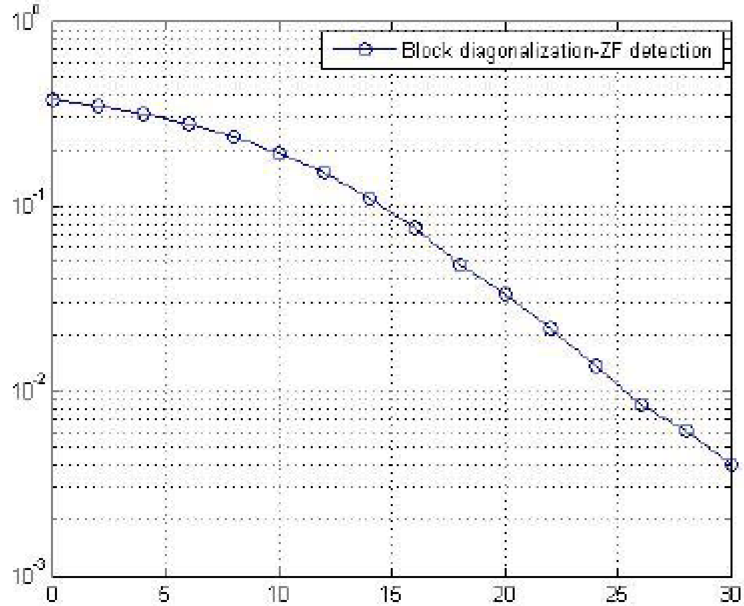

Figure 1: SNR vs BER for BD

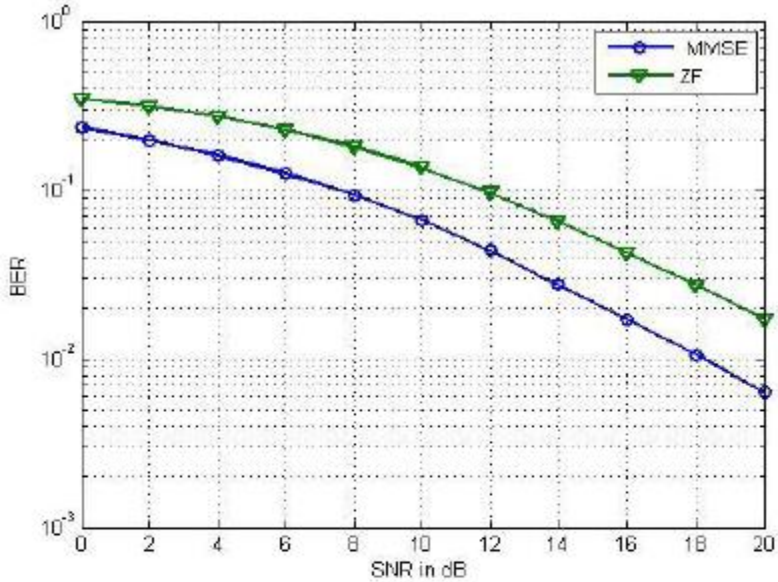

Fig. 2: SNR vs BER for MMSE & ZF

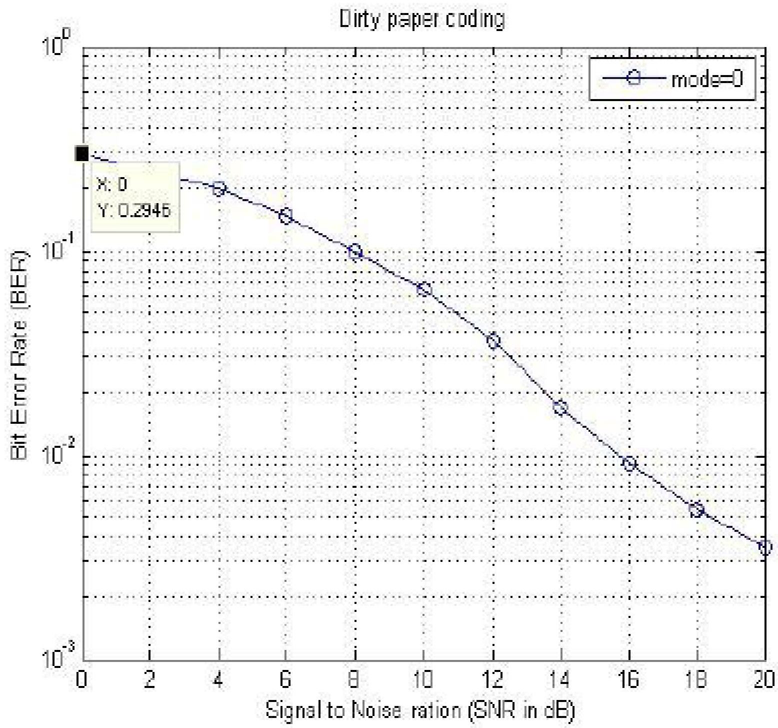

Fig. 3: SNR vs BER for DPC

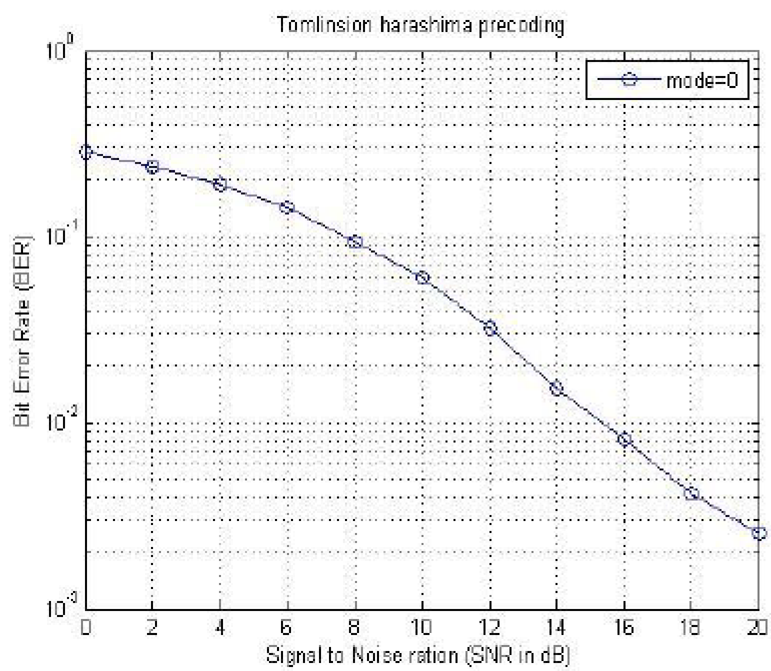

Fig. 4: SNR vs BER for THP

Table 1: SNR vs BER Comparison of MIMO Downlink Precoding Techniques.

X	MMSE	ZF	BD	DPC	THP
0	0.2349	0.3486	0.3774	0.2946	0.2848
4	0.1606	0.2723	0.3151	0.1988	0.1904
8	0.0904	0.1808	0.2362	0.0995	0.0938
12	0.04381	0.09649	0.1520	0.3587	0.0322
16	0.01711	0.04276	0.07637	0.0091	0.0080
20	0.0062	0.01718	0.03325	0.0035	0.0025

SNR **BER (dB)**

V. CONCLUSION

From the reproduction table we can infer that for multi-client MIMO on Downlink side different precoding procedures are presented and among them Tomlinson-Harashima Precoding (THP) method is best which gives better SNR to BER yield. So also for multi-client single recieving wire Minimum mean-square-blunder (MMSE) performs better yield then other direct precoding methods.

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