A Novel Precoder Design for LTE Multicell Multiuser MIMO Systems Using BD, BD_DPC & ZF Precoding & It's Validation by Nash Equilibrium

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Abstract: ***This work concentrates on a MU MC framework where BD precoding is used for every cell premise. The MC framework under two working modes is analyzed: competition and coordination. Now in opposition mode, this work studies a key non-agreeable game, here every base-station insatiably decides its BD precoding methodology in conveyed way, in light of the information of the between cell obstruction at its associated versatile stations. By means of the game notion structure, the individuality and presence of NE in this SNG are thusly concentrated on. In the coordination mode, the BD pre-coders are mutually outlined over different BSs to enhance the system WSR. Since this WSR amplification issue is non-convex, so consider a distributed algorithm to acquire no less than a locally optimal solution. At long last, broaden the investigation of the MC BD precoding to the instance of BD-Dirty Paper Coding precoding. BDDPC precoding diversion for the MC framework in the opposition mode is been described and proposes a calculation to mutually upgrade BD-DPC pre-coders for the MC framework in the coordination mode.***

Keywords: Competition Mode, Coordination Mode, Nash Equilibrium, Precoding, Block Diagonalization

1. Introduction

In a multiple input multiple output (MIMO) framework, SDMA stay connected at BS to simultaneously multiplex information streams for various MS. With proper downlink precoding procedures at the BS, SDMA can altogether enhance the framework ghostly effectiveness. The exploration on downlink precoding for a various information different yield (MIMO) framework has been a dynamic territory for a long time.DPC has been turned out a limit accomplishing MU precoding technique. Notwithstanding, because of its high multifaceted nature usage that includes arbitrary nonlinear encoding and translating, DPC just stays as a hypothetical benchmark. Therefore, direct precoding systems, for example, zero-driving (ZF), piece diagonalization (BD), get to be engaging options because of their effortlessness and great execution. With BD precoding, transmitted sign from BS planned for a specific MS is limited in invalid area made by the DL conduits connected with various MS's. Subsequently, all between client impedance inside of the cell at the MSs can be completely smothered. The NE (Nash Equilibrium) of the multicell amusements is required to be interesting if the ICI is adequately little. It is expected that the performance of BD_DPC multicell precoding game is better than BD game, while the sum rate achieved is very near to the DPC precoding game. For nonconvex WSR maximization problems, distributed ILA algorithm method is used to find at least a local optimum result when the functioning mode of multicell system is coordination mode. Over a multicell system it is possible to increase the network sum rate by synchronizing BD or BD_DPC precoders over competition mode. In this work it is noticed that only single carrier systems are treated. Resource allocation is possible in multi carrier system.

2. System Model

To generate system model for MU MC Downlink system having Q distinct cells functioning on the identical frequency passage. Kq number of remote MSs, receiving data through independent data streams sent by BS with multiple antennas simultaneously from a specific cell, take cell_q. Antenna numbers at every BS denoted by M_q and antenna numbers at every MS is denoted byN_{qi}.The transferred sign vector from BS-q is symbolized as$x_q \in C^{M_q \times 1}$. x_q is represented as$x_q = \sum_{i=1}^{K_q} W_{qi} s_{qi}$, by assuming linear precoding at BS, where $W_{qi} \in C^{M_q \times L_{qi}}$ is the precoding matrix and $s_{qi} \in C^{L_{qi} \times 1}$ is taken as information sign vector proposed for MS-i ,number of symbols which are transmitted are denoted by L_{qi}.prospect of $s_{qi} * s_{qi}^H$ is presumed to be one, i.e.,$\mathbb{E}[s_{qi} s_{qi}^H] = I, \forall i, \forall q$.without losing its platitude.

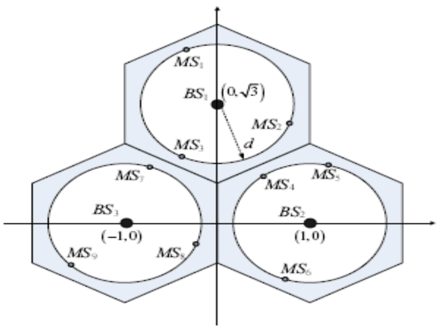

Figure 1: System Model

Channel coefficients model for connecting BS-r to MS-i of cell q is given by the relation $H_{rqi} \in C^{N_{qi} \times M_r}$ and z_{qi} is the arbitrary covariance matrix which models the zeromean compound additive Gaussian clamor vector. At cell_q transmission to MS_i is expressed as follows

$$y_{qi} = \sum_{r=1}^{Q} H_{rqi} x_r + z_{qi}$$

$= H_{qqi} W_{qi} s_{qi} + H_{qqi} \sum_{j\neq i}^{K_q} W_{qj} s_{qj} + \sum_{r\neq q}^{Q} H_{rqi} \sum_{j=1}^{K_r} W_{rj} s_{rj} + z_{qi}$ ………. (1)

From equation (1) observed that signal received at MS-i in cell-q comprises of four parts: suitable data signal $H_{qqi} W_{qi} s_{qi}$, the intra-cell impedance $H_{qqi} \sum_{j\neq i}^{K_q} W_{qj} s_{qj}$, the between cell obstruction $\sum_{r\neq q}^{Q} H_{rqi} \sum_{j=1}^{K_r} W_{rj} s_{rj}$, and the Gaussian commotionz_{qi}. Assume that every MS is capable of measuring its total interference and noise power (IPN) faultlessly and continuously feeding back this information to its linked BS for this work. To estimate and feedback for downlink CSI from every MS the same assumption is made. By using the CSI and IPN information BS designs a precoder for the MS which are linked to it. To combat the deficiencies in CSI or IPN data at the BS by its connected MS, then there is a need for redesigning for the precoders.

It is assumed in system models, competitive design, every BS is provided with full information of channels in downlink for MS in the cell of its own but MSs are not aware of the channels, present in other cells. Due to this fundamental clamor is induced at MSs because BS inevitably introduces ICI to the cells which are in its vicinity. In contrast every BS is provided with full information of channels in downlink for MS in the cell of its own and also aware of the channels, present in other cells which are in its vicinity.

The knowledge of channel obtained additionally will be used to control ICI by BS. Here it is witnessed that by executing per cell basis precoding techniques BS completely takes care of intra cell interference. For MSs with multiple antennas, recommending a precoding technique is the emphasis in this particular work to suppress intra cell interference, named as BD precoding.

BD precoding for every cell premise is implemented, by assuming following condition i.e.,$\sum_{i=1}^{K_{qi}} N_{qi} \leq M_q, \quad \forall q$, which says that the number of receiver antennas that are present at MSs should not surpass transmitting antenna numbers which are associated at their BS. By using low complexity selection techniques, the BS can chose a subclass of MSs before itself, if numbers of antennas to receive are more than number of antennas used to transmit.

Let $Q_{qi} = W_{qi} W_{qi}^{H}$is the proposed convey covariance matrix for MS-i, which is present in cell-q, and the precoding outline for K_q MSs which are present in cell-q, is given as$Q_q = \{Q_{qi}\}_{i=1}^{K_q}$. The precoding outline of all cells excluding cell-q, is expressed by the following relation$Q_{-q} = \{Q_1, \ldots, Q_{q-1}, Q_{q+1}, \ldots, Q_Q\}$. $R_{qi}(Q_{-q})$ Denotes the covariance matrix of the IPN with no intra-cell interference in the MS-i present in cell-q, is expressed as

$$R_{qi}(Q_{-q}) = \sum_{r\neq q}^{Q} H_{rqi} \left(\sum_{j=1}^{K_r} Q_{rj}\right) H_{rqi}^{H} + Z_{qi} \quad (2)$$

The attainable information rate R_{qi} to MS-i by applying BD precoding on a per-cell basis at BS-q, is given by

$$R_{qi}(Q_q, Q_{-q}) = \log|I + H_{qqi}^{H} R_{qi}^{-1}(Q_{-q}) H_{qqi} Q_{qi}| \quad (3)$$

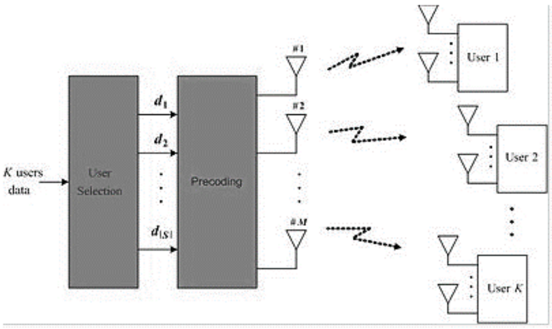

Figure 2: Block Diagram of Downlink Precoder

2.1 The MC BD Precoding - Coordinated Design

The interest lies in figuring this aggressive multicell BD precoding plan utilizing the amusement hypothesis structure. Specifically, a SNG (key non-agreeable diversion) is considered in which BSs are playing the role of players and cells sum rate is the reckoning function.BS deliberately adopts BD precoder on each cell basis which hungrily exploits sum rate to its linked MSs, focuses to limitation on its transfer power. Here the game being played when assumed that all the channels are considered fixed because channels are varying adequately slow.

Set having Q players is given as Let $\Omega = \{1...Q\}$.Reward or payoff function for player q is stated as$R_q\{Q_q, Q_{-q}\} = \sum_{i=1}^{K_q} R_{q_i}\{Q_q, Q_q\}$. By using the below optimization method, player q greedily exploits its reward or payoff function and $Q_q$is the plan outline for other players

$$\underset{Q_{q1},\ldots,Q_{qK_q}}{\text{maximize}} \; R_q(Q_q, Q_{-q})$$
$$\text{subject to} \; H_{qqi} Q_{qi} H_{qqi}^{H} = 0, \forall j \neq i$$
$$Q_{qi} \geq 0, \forall i$$
$$\sum_{i=1}^{K_q} \mathrm{Tr}\{Q_{qi}\} \leq P_q \ldots (4)$$

At BS_q power limit is specified by P_q.assume that the IPN matrix $R_{q_i}(Q_q)$ is measured flawlessly at corresponding MS_i and informed back to its connected BS. This process is followed to achieve supreme sum data rate at cell_q.

By expressing precoding covariance matrixQ_{qi} as $\hat{V}_{qi} D_{qi} \hat{V}_{qi}^{H}$ BD limits can be removed. Where D_{qi}a random is $\hat{N}_{qi} \times \hat{N}_{qi}$ and $\hat{V}_{qi}$ restating the problem of optimality as

$$\underset{D_1,\ldots,D_Q}{\text{maximize}} \sum_{q=1}^{Q} \alpha_q \sum_{i=1}^{K_q} \log\left|I + \widehat{V_{qi}}^{H} H_{qqi}^{H} R_{qi}^{-1}(D_{qi}) H_{qqi} \widehat{V_{qi}} Q_{qi}\right| \ldots\ldots\ldots (5)$$

$$\text{subjectto} D_{qi} \succeq 0, \forall q, \forall i$$
$$\sum_{i=1}^{K_q} Tr\{D_{qi}\} \leq P_q, \forall q \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

It is watched that the target capacity in Eq (6) is not inward because of nearness of D_{rj} 's in the ICI expression$\hat{}R_{qi}(D_{-q})$'s. Hence, the enhancement issue in Eq (6) is not curved. Thusly, which is for the most part troublesome and computationally complex to discover its comprehensively ideal arrangement. To this end, we concentrate on proposing a lower-multifaceted nature calculation that can acquire no less than a locally ideal arrangement.

2.2 Competitive Design in the MC BD-DPC Precoding

Here game $\mathcal{G}'$ is taken, in order to exploit the sum rate of its associated MSs, each BS greedily regulates its precoding plan, and other BSs strategies are revealed by ICI. Scientifically, diversion $\mathcal{G}'$ is expressed as follows

$$\mathcal{G}' = \left(\Omega, \{S'_q(\pi_q)\}_{q\in\Omega}, \{R_q\}_{q\in\Omega}\right), \ldots\ldots\ldots (7)$$

$S'_{q(\pi_q)}$Is the strategies set which are admissible, are defined as

$$S'_q(\pi_q) = \left\{Q_{\pi_q(i)} \in S^{M_q\times M_q} : Q_{\pi_q(i)} = \hat{V}_{\pi_q(i)} D_{\pi_q(i)} \hat{V}^H_{\pi_q(i)}, D_{\pi_q(i)} \geq 0, \sum_{i=1}^{K_q} Tr\{D_{\pi q(i)}\} \leq P_q\right\} (8)$$

Here $\widehat{H}_{\pi_q(i)}$creates a null space, which is denoted as $\hat{V}_{\pi_q(i)}$ .games G andG'posses the similarities in their characters. In game G' always at least one NE exists and uniqueness condition for NE is given by the condition below,

$$(C'): \rho(S') < 1, \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where $\in \mathbb{C}^{Q\times Q}$,$\hat{}V_{\pi r} \triangleq [\hat{}V_{\pi r(1)}, \ldots, \hat{}V_{\pi r(K_r)}]$

$$[S']_{q,r} = \begin{cases} \sum_{i=1}^{Kq} \rho\left(\hat{V}^H_{\pi r} H^H_{r\pi q(i)} \bar{\bar{H}}^H_{r\pi q(i)} \hat{V}^H_{\pi q(i)} \hat{V}^{\#}_{\pi q(i)} H^{\#}_{q\pi q(i)} H_{r\pi q(i)} \hat{V}_{\pi r}\right), \text{if} r \neq q \\ 0, \text{if} r = q \end{cases}$$
(10)

In this part the MSs which are connected to BS uses BD_DPC precoders in MC system for the transmissions in downlink. For single antenna receivers DPC encoder is used which provides simple version of ZF-DPC and broadcast channel with suboptimal solution. Here the benefits of ZF and DPC are exploited. Since ZF and DPC are used at the BS the information sent to multiple users using ZF-DPC in sequence these are encoded to avoid inter user interference. Here receivers with multi antenna are considered and it is titled as BD_DPC precoding. The technique applied here is similar to ZF-DCP.

3. Results and Analysis

The proposed framework in Figure 1is reproduced in MATLAB programming utilizing MATLAB programming dialect. Figure 3 shows the plot of NE's Uniqueness Probability vs. BS-MS Intra-Cell Distance. Here the graph is plotted for both block diagonalization (BD) precoding and BD_DPC precoding. Consider that the distance dis small, then that region is low ICI region and great signal to interference plus noise (SINR) region in which NE's uniqueness increases. From the Figure 3 it is clear that at lower distances the probability of NE's uniqueness is high. In divergence if the distancedis large, then every MS is more prone to low SINR region and higher level of ICI. Therefore the NE's uniqueness probability also drops at higher distances. As perceived from figure 6.5, the NE's uniqueness is assured at adequately small ICI levels. The ICI level increases as the MS reaches the cell edge due to this NE's uniqueness also decrease. The uniqueness circumstances in BD are much weaker than BD_DPC.

Figure 4 shows the plot of Sum Rate of Network Vs Transmit Power to Noise Ratio. The above figure explain the IA mode and IC mode network sum rate against the transmit power to noise ratio, which is given by the following expression$\frac{P}{\sigma^2}$, the distance d is set to the value of 0.7, at all the Q BSs the power budgetP assumed to be same. By considering IC and IA modes it is observed that the network sum rate increased because every BSs is increasing its transmit power. As the transmit power increases gradually the network sum rate attains saturation condition. Because the increase in signal power leads to increased intra cell data signal power which leads to relatively higher ICI. The quantity of ICI can be limited and coordinated only in IC mode which is a very desirable scenario. The performance parameters in IA mode are not significantly good compared to IC mode, with all the precoding techniques at high ICI region.

Figure 5 shows the plot of Sum Rate of Network Vs BS-MS Intra-Cell Distance using Zero Forcing precoder. Designing BD precoder using Zero Forcing algorithm in IA mode and IC mode is the main aim of the anticipated work. Zero Forcing algorithm is the simplest algorithm, with simple calculations and reduced complications. By using this algorithm same network performance can be achieved as that of BD-DPC, BD. Zero forcing algorithm multiplies the inverse of the frequency response of the channel with the channel matrix in order to nullify the effect of interference. As the name indicates this algorithm forces the interference to become zero, hence the name Zero Forcing algorithm. The plot witnesses that the networks sum rate is high at lower BS-MS intra cell distance, with increasing distance the network sum rate decreases. Compared to IA mode the network sum rate is high in IC mode.

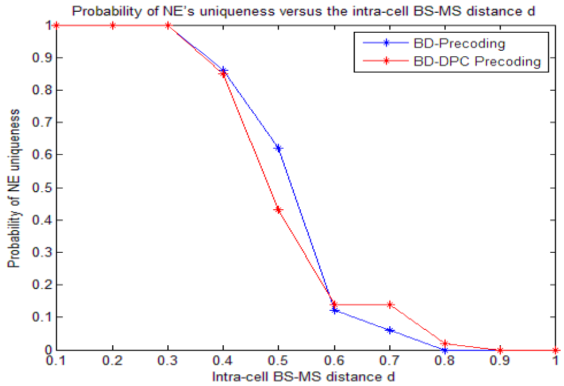

Figure 3: Plot of NE's Uniqueness Probability vs BS-MS Intra-Cell Distance

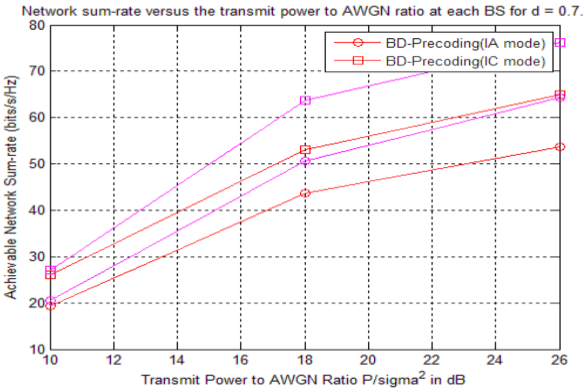

Figure 4: Plot of Sum Rate of Network Vs Transmit Power to Noise Ratio

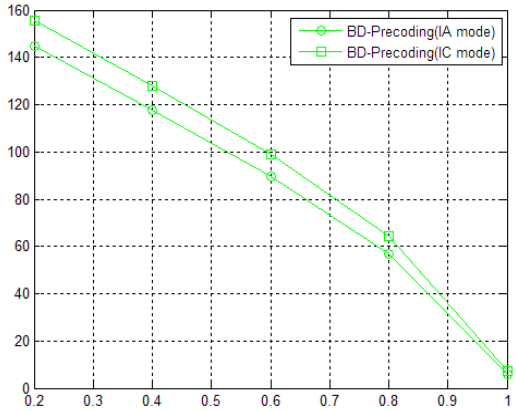

Figure 5: Plot of Sum Rate of Network Vs BS-MS Intra-Cell Distance in ZF Precoder

4. Conclusion

This anticipated work is designed using MATLAB which is known for its flexibility and dependability. Rapidly growing wireless technology is reaching almost every individual, which leads to demanding the networks with improved performance and great speeds. By increasing the speed of accessibility the MIMO systems can provide higher mobility with higher date rates. The framework proposed is to design a precoder for downlink in MIMO systems. The connection between BS to MS is identified as downlink. Here precoder using BD, BD_DPC and ZF algorithm is designed and results are verified under IA mode and IC mode. Comparison plots are plotted for network performances under several circumstances. ZF precoding gives almost same network performance as BD, BD_DPC but calculation difficulty reduced to a pronounced magnitude. In this work it is noticed that only single carrier systems are treated.

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