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Research Article

I.

Co-operative transmission assisted Interference Alignment (IA) Technique forImproving the Performance of Small Cell HetNetUsers

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Abstract

Interference Alignment (IA) in Heterogeneous Networks (HetNets) is a challenging task due to the integration of diverse communicating equipments and wireless technologies. The channel access and allocation period of the communicating equipment's vary with time and frequency domain, creating less feasibility in IA.In a heterogeneous network with interoperable features, communication in small cell is rationalized by proper interference alignment in concurrent channel access and licensed spectrum usage. In this article we introduce a co-operative transmission assisted linear interference alignment (IA) technique for improving the spectral efficiency of small cell user equipment (UE). The proposed linear optimization based IA classifies the transmitted signal with the intermediate interference receiver signals. Based on the observation, the identical signal input vectors are classified to suppress interference at the receiver end. Besides, the non-identical signal vectors are independently classified to improve the degrees of freedom (DOF) as a measure for improving spectral efficiency of the UE. The performance of the proposed IA technique is assessed using simulations and the DOF, spectral efficiency is accounted for comparison.

Keywords—Heterogeneous Networks, Co-operative transmission Interference Alignment, Optimization, Signal Classification, Degree of Freedom, Spectral Efficiency

II. INTRODUCTION

The compatibility support with several technology based orchestration is needed for mobile and wireless communication.

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To offers continuous presentation to design Heterogeneous Networks (HetNets), a widespread of miscellaneous device and communication skills is integrated. To increase the scalability covers the network and throughput of the users which are communicating for the execution range for that the HetNets are designed. For the patented users and base station, the HetNet is divided eachcell into minor and major cells. According to the users demands the coverage area and the devices power is various for each cell is selected arbitrary [1, 2]. In the HetNets coverage signal in the major is jammed to interruption problems occurs because of the merging from the major cell layer. To maintain the presentation of the network is handling by the intrusion. To avoid jamming in the major cell to the minor cell which offloads the resource in the conservative intrusion administration process in HetNets. A particular cell is overloaded where the time of the co-channel intrusion is usual and the computation is difficult and the rate of conjunction is large. The leakage problem occurs in the output due to this conjunction disturbs the degree of freedom (DOF). Because of the offloading progress resulting, the minor cell signal is blocked and resulting presentation deprivation of the users in the minor cell. The process is to identify the blockage handling in offloading progress to preserve the major and minor cell user's presentations; the introduction of the interference alignment is in the latest years. The signal processing is identified by the interference alignment (IA) as a consistent of time, frequency and space.To identify the leakage interference at early stage in small cells a Gaussian-Newton model is proposed in [5], which classifies the signal using Jacobian and Hessain Matrix.

In the whole exceeding cases by assessing the interference and the signal in the end of the host is to sense the solution key [6]. By The design of the search space and vector molding false signal and interference is distinguished in the destination. The primary and secondary communicating users develop the concurrence by the sensing and extenuation of intrusion between minor and major cells in the network communication specific signal detecting. A clustering method by considering density and path loss is proposed in [8].

The significant of IA in the wireless network system to showed in increasing the remunerations over the sensed IA method [9]. To alleviate co-channel intrusion is introduced by the fractional inter cell IA method. A cross layer IA is proposed in [11] it is various from the following scheme. For multiple user HetNets this method is matched. For identifying the interference concerns in 5G networks MAC and PHY is integrated in the design of the cross layer. Aziz et al. [12] proposed the pre coding scheme transmit method for searching the transmitter signal in the receiver destination. The HetNets particular user selection procedures introduced is used to avoid excessive interference.

To increase the volume of huge scale system the Interference alignments is identified as the convex escalation problem in [13]. According to the casual matrix construction for solving the complex escalation concerns is proposed by the author. An IA for minor and major cell network communication in the huge scale procedures with the combined valuation of the Signal interference noise ratio and bit error rate is proposed by the author in [14]. D.Prabakar et al. [15] proposed a nonlinear optimization IA method using boundary condition.Bazzi et al [16] proposed the Multi-input multi-output interference channel. This IA is based on asymptotic Eigen value distribution (AED). By monitoring the rate of terms and vector signal received demonstrations for distinguishing the transmitted signal for designing interference alignment. For MIMO interference channel the hybrid interference alignment (HIA) method is proposed by the Feng et al. [17]. By the combination of seeing the signal to leakage noise ratio (SLNR) and SINR as average sum rate of maximizing the receiver is proposed for a multiple user atmosphere.

III. PROPOSED METHOD

In this manuscript, a co-operative transmission assisted IA method is proposed. This IA method inherits the advantages of linear independent vector optimization and co-operative DOF based decoding for improving the sum rate of small cell networks. Typical small cell architecture is represented in Figure 1. The network is modeled with N small cell users exploiting the unlicensed spectrum of the core network. The core network consists of service providers and access points that render their licensed band for secondary users (Small cell)

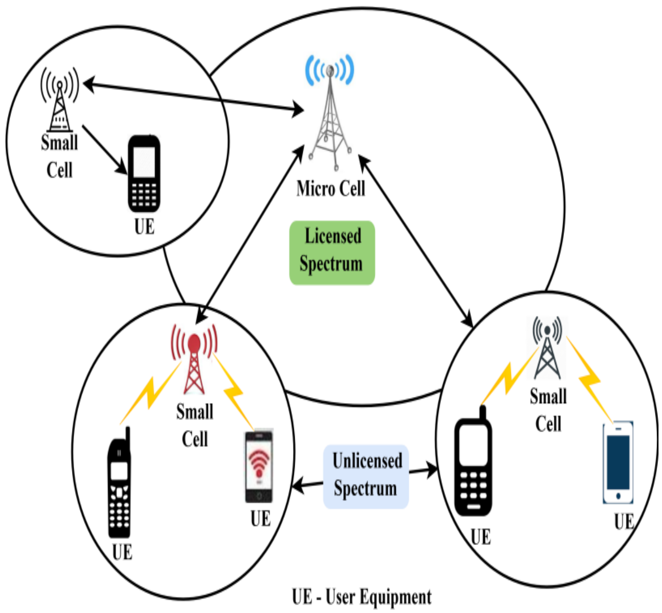

Fig. 1. System Architecture

The small cell with N users communicates through a channel c with k transmitters. The user equipment (UE) exploits m antennas in the allocated channel c. Let A_i and B_i represent the channel co-efficient matrix of the i^{th} receiver. We estimate the prior encoding and decoding of the m antennas in c. The communicating user relays control signal $p_i = \{p_{i1}, p_{i2}, \dots . p_{im}\}$ and data signals $q_i = \{q_{i1}, q_{i2}, \dots . q_{im}\}$ at different time intervals. For the first set of communication, the transmitters/ receiver pairs are assumed to be interference free. This is in coherence with the time synchronized co-operative transmission behavior of multiple transmitter/receiver pairs. Therefore, for a total of $m \times m$ transmitters, let M_2 and M_1 be the matrix that represent the A_i and B_i. Figure 2(a) illustrates the assumed co-operative communication between TX/RX pairs.

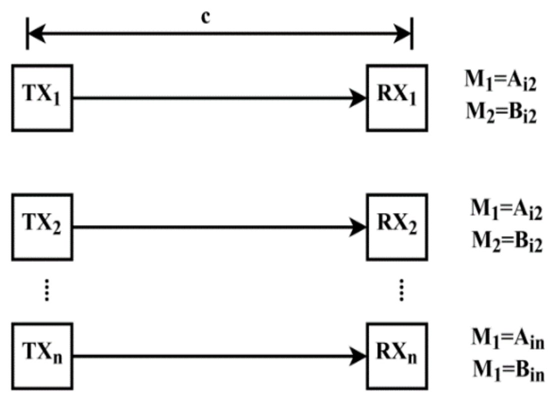

Fig. 2(a). Initial TX/RX non-Interference

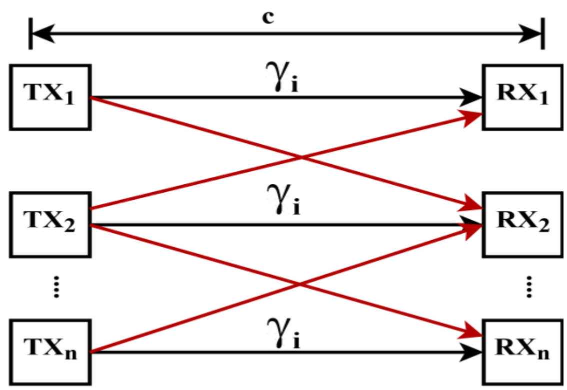

Fig. 2(b). Final TX / RX Interference

The transmitted signal X_i including p_i and q_i is given by equation (1)

$$X_i = \frac{1}{B_i}|M_2 p_i| + \frac{1}{A_i}|M_1 q_i| \quad (1)$$

This signal follows conventional encoding process as represented in equation (1). At the receiver end, the signal is decoded as

$$Y_i = \sum_{i=1}^{k} B_i \frac{1}{A_i}|M_2 p_i| + A_i \frac{1}{B_i}|M_1 q_i| + M_1 \sum_{i=1}^{k} q_i + \gamma_1 + M_2 \sum_{i=1}^{k} p_i + \gamma_2 \quad (2)$$

Where γ_1, γ_2 are the random alignment vectors representing M_1 and M_2 respectively. The mediate signal at an RX $(y_i)$is given as

$$y_i = \sum_{i=1}^{k} \sum_{j=1}^{m} (\alpha_{ij} p_{ij} + \beta_{ij} q_{ij}) + \gamma_1 \quad (3)$$

Here, α_{ij} and β_{ij} represents the vector elements of the i^{th}row and j^{th} column of M_1 and M_2 correspondingly. The degree of freedom (DOF) for the above Y_i or an independent y_i is estimated as

$$DOF_i = \lim_{p_0 \to \infty} \frac{1}{2} \frac{\log(2 D_i - 1)}{\log p_0} \quad (4)$$

Where p_0 is the transmit power and D_i is the data stream in intermediate y_i such that $\sum_{i=1}^{m} y_i = Y_i$ and $D_i \in Y_i$. The intermediate signal at the RX(i.e.)y_i is analyzed for interference alignment. Here, IA is instigated if the co-operative communication is asynchronous of time. Let t_t and t_r represent the represent the transmitting and receiving time instances of the TX/RX pair. Synchronized transmission is achieved by constant variation between t_t and t_r. If the difference between Let t_t and t_r is small/high compared to the previous instance, theny_i is assessed. These assessments consider X_i and intermediate y_i for IA using linear independent vector optimization. Let us represent theX_i in a homogenous equation of the form

$$\left.\begin{aligned} 2p_i + 2q_i - M_1 + M_2 + A_iB_i = 0 \\ -p_i - q_i + 2M_1 - 3M_2 + A_iB_i = 0 \\ p_i + q_i - 2M_1 - A_iB_i = 0 \\ M_1 + M_2 + A_iB_i = 0 \end{aligned}\right\} \quad (5)$$

Now, the covariant matrix for equation (5) is given by

$$CM_{Xi} = \begin{pmatrix} 2 & 2 & -1 & 0 & 1 & 0 \\ -1 & -1 & 2 & -3 & 1 & 0 \\ 1 & 1 & -2 & 0 & -1 & 0 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{pmatrix} \quad (6)$$

The covariant matrix is analyzed using row echelon operation such that all the input vectors p_i, q_i, M_1, M_2 and A_iB_i are independently resolved. Similarly, the received y_i is segregated as

$$\left.\begin{aligned} \alpha_{ij}p_{ij} + 2\beta_{ij}q_{ij} = 0 \\ -2\alpha_{ij}p_{ij} - 2\beta_{ij}q_{ij} = 0 \\ \alpha_{ij}p_{ij} = \tfrac{1}{2}\beta_{ij}q_{ij} = 0 \end{aligned}\right\} \quad (7)$$

By applying covariant matrix and row echelon operation, the vectors p_{ij} and q_{ij} are segregated with independent values. Let p_{ij} and q_{ij}represent the row and column elements of Xi such that equation (5) is resolved using column and row vectors. Therefore, for an unsynchronized time interval of communication, we have two sets of independent linear results by mapping CM_{Xi} with CM_{yi} where the like elements get cancelled. Therefore, the vectors in both CM are equated such that non-identical vectors form the solution vectors. As the solution vectors are non-identical, these are considered as the alignment vectors ofYi. The γ_i of the TX/RX pair relies on the non-identical i^{th} or j^{th} matrix element. From this point, the vector that proceeds with alignment $\in \gamma_i$ or the vector with max$\{DOF_i\}$ belongs toγ_i. The IA model is considered for a transmitter-receiver antenna pairs as illustrated in Figure 2(b). Consider that p^{α} interference is bound to null, then

$$\left.\begin{aligned} rank\ (p^{\alpha}q^{\alpha}.AB^{\alpha\alpha}) = \emptyset^{\alpha} \\ such\ that\ p^{\alpha}q^{\alpha}.AB^{\alpha\alpha} = 0, \forall\ j \neq k \end{aligned}\right\} \quad (8)$$

Where, $AB^{\alpha\alpha} = p^{\alpha}.q^{\alpha}$ represent the co-efficient matrix of i of the transmitting user a and receiving user b (say), hence, the more optimal j is denoted as

$$o^{\alpha} = AB^{\alpha\alpha}\bar{X}^{\alpha} + AB^{\alpha} \quad (9)$$

Where $\gamma^{\alpha} \sim (0, AB_m^{\alpha})$ where I_m is the identity matrix of $[\alpha\alpha]$. The user with high degree of freedom has multiple chances for switching over communication in the small cell if it faces interference. The density of users influences the sum rate by increasing the interference level. The pre-coding process reduces the interference level within the user and cell level.

IV. SIMULATION RESULTS

We consider a small cell network distributed in a 0.5 Km x 0.5Km region, 50 cells are deployed withvarying user densities and with a transmit power of (0-45) dBm. Table 1 presents the simulation parameters for the proposed technique.

TABLE 1 Simulation Parameter and Values

Parameter	**Values**
Network Region	500m x 500m
Number of Cells	50
Path Loss Model	Rayleigh Fading Path Loss
Bandwidth	180kHz
Noise Power	10^{-7}
Path Loss Exponent	3.76

The proposed IA is compared with the existing methods in AED-IA [16] and HIA [17] for the metrics of spectral efficiency and DOF.

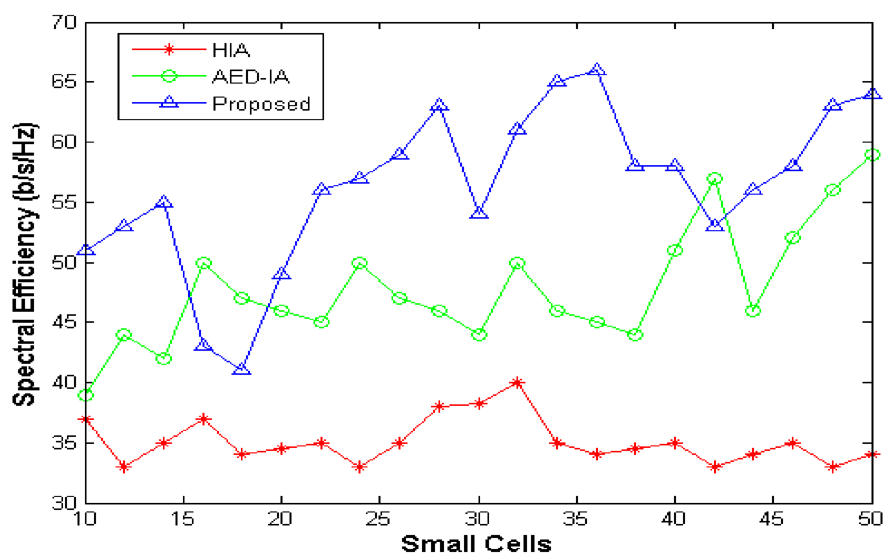

Fig. 3(a) Spectral Efficiency Comparisons

In Figure 3(a), the spectral efficiency is compared between the existing and proposed methods with respect to the number of small cells. In Figure 3(b), the spectral efficiency with respect to the transmit SNR is compared.

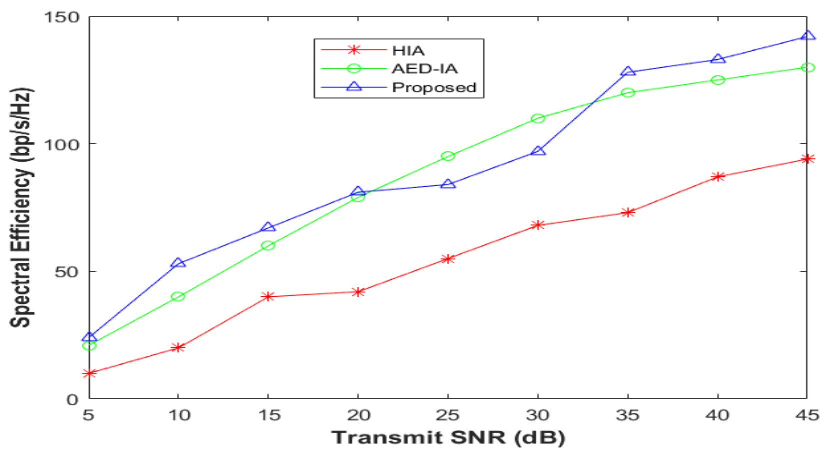

Fig. 3(b) Spectral Efficiency with respect to Transmit SNR

In both the cases, the classified intermediate signal is analyzed for detecting the identical and non-identical transmission vector for interference alignment. The vector based linear optimization provides generic solutions for interference detection in the receiver side.

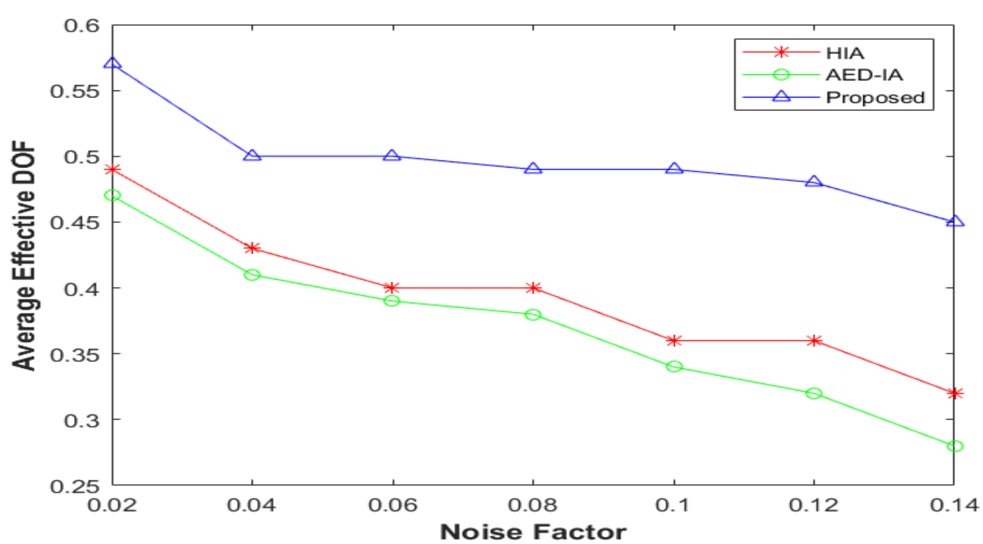

Fig 4DoF Analyzes

The proposed method achieves better DOF by classifying the transmitted signal for non-interference and intermediate IA analysis. The proposed liner vector optimization based IA also classifies the identical and non-identical vectors at the receiver endto suppress the interference thereby improving the DOF.The simulation results are tabulated in Table II.

Table II Simulation Results and Comparison Values

Metrics	**HIA**	**AED-IA**	**Proposed**
Spectral Efficiency (b/s/Hz) vs Small Cells	34	59	64
Spectral Efficiency (b/s/Hz) vs transmit SNR (dB)	94	130	142
Avg DoF Vs Noise factor	0.32	0.28	0.45

V. CONCLUSION

In this manuscript, a cooperative transmission basedIA is designed to improve the spectral efficiency of small cell users in HetNets. The transmitted signal is classified for non-interference and intermediate for IA analysis. The analyzed signal is preceded over liner vector optimization for identifying identical and non-identical vector for interference alignment. The analyzed signal is then spawned using rank method for achieving betterDoFand spectral efficiency. Simulation results prove the consistency of the proposed technique by achieving optimizedDoFand spectral efficiency compared to the existing methods.

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