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The Effectives within Joint Beamforming and Channel State Information (CSI) in Massive MIMO Systems

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ABSTRACT

We suppose that the BS estimates the channel viachannel state information (CSI) to joint beamforming including minimum mean square error (MMSE) scheme in the field of massive multiple input multiple-output (MIMO). Herein, multiple users are scheduled that can be exploited to increase the system throughput and reducing as well as suppressing the interference. Thus, strong signal gains are achievable so that amplification gain is maximizing the system energy efficiency (EE) while maximum transmission power constraints and guaranteeing spectral efficiency (SE) requirements.

Introduction

For 5G networks, the key techniques to address the requirements is the Muliple-input multiple-output (MIMO) technology such as spectrum utilization, coverage, by improving energy efficiency , by increasing capacity without the need of increasing an operational bandwidth and so on[1].Multiple antennas can be exploited to focus signals on intended receivers to increase the system throughput when reducing interference that it has been offered by the spatial degrees of freedom when scheduling multiple users on the same time frequency resource[2-7].Too, each user getting high throughput for such very large systems when in the same time-frequency resource that the base station (BS) can serve a multiplicity of autonomous users[8].

From view in [8], we appeared that maximal ratio combing (MRC) accomplishes as well as zero forcing (ZF) and MMSE that a throughput of an order of about 1 bit per channel useforeach user in regime**,** whilst the optimal linear detector for single-cell systems is obtained with MMSE.

Since over the statistics like phase, time, frequency that the signal is spreaded. These statistics has a great impact on received signal and define the channel selectivity. We need channel State Information (CSI), at the receiver side, for data equalization and detection. There are two ways for channel estimation such as its classification- one is blind channel estimation and second the Training based channel estimation[9].Thereby,in order to enlarge the capacity of legal channel, relays just perform distributed beamforming directly to the legal destination as much as possible by the cooperative beamforming (CB)-based relay systems[10].Whilst, one of the analog RF beamforming schemes has equal gain transmission which controlling only phase of signal with phase shifters. Also, there is with the limited number of RF chains that analog-digital hybrid beamforming techniques, especially in mmWave beamforming systems ,are considered to reduce the hardware complexity[11-14].

1.2Methods of Channel Estimation(CE)

There are two types of CE methods. One is blind i.e. without training sequences and other one is training based. Different types of channel estimations and in general they can be categorized as blind channel estimation, training based estimation and semi blind estimation. The pilot bits to be sent along with the data are required with the training based . The pilot bits are arranging to can be comb type [15] and block type[16]. In comb type pilots are sent for whole time but while in block type transmission of pilot is done on each and every subcarrier at successive intervals of time. Blind channel is used as it due to it does not wastes bandwidth as no pilots are needed and that considers as advantageous[15].

Herein, we let to express mathematically for one system model of MIMO as given in [16]:

$F = XB + S(1)$

where F is the received vector, B is the input data matrix,X channel matrix and S is the noise matrix.

1.2 Method of MMSE

Computing the mean square error then minimizing the same is obtained by the MMSE via estimator. Although, the MMSE has one con where is the complexity in term computations is increased but this estimator implements better than anther such as the last error estimator (LS)type. Here hermitian shell represent as $(.)^H$(conjugate transpose). MMSE is obtained by:

$$\hat{H}_{MMSE} = R_{BF} R_{FF}^{-1} F \quad (3)$$

where R_{BF} is cross-covariance of B& F R_{FF} is auto –covariance of F

Also, $$R_{\theta F} = E[XF^X] = E[\vartheta(X\vartheta + S)^X] \quad (4)$$

$$\&R_{FF} = E[FF^X] = E[(XB + S)(XB + S)^X]$$
$$= E[XB(XB)^X + XBS^X + SS^X]$$
$$= XR_{BB}X^X + \sigma_n^2 I \quad (5)$$

Thereby, the $R_{BB} = E[BB^H]$ which represents the auto covariance of channel matrix B, I is identity matrix. So that, we should have a prior for the estimator that are known such as $R_{\vartheta\vartheta}$& a noise variance $\sigma_n^2 = E[M^2]$.

Now put the values in (3) we get, $\vartheta'_{MMSE} = R_{BB} O^X (X R_{BB} X^X)^{-1} F$

$$\vartheta'_{MMSE} = R_{BB}(R_{BB} + \sigma_n^2 (X^X X)^{-1})^{-1} X^{-1} F \quad (6)$$

1.3 Beamforming technique

The use technique to partition Beamforming between RF and the digital domains is called hybrid Beamforming. System designers ,with it, can perform a balancing cost tradeoff and flexibility thereby a system meets the required performance parameters while it still fielding. By combining multiple array elements into subarray modules that has been developed for the hybrid beamforming designs. Due to fewer atransmit/receive T/R modules are required in the system, in the array, so that this module is dedicated to a subarray. For ensuring system-level performance can be selected when there is met across a range of steering angles ,the positioning within each subarray and the number of elements[18].

However, using the baseband beamforming blocks can be to create multiple beams from the array to cover multiple users concurrently, as shown in Figure 1[19].

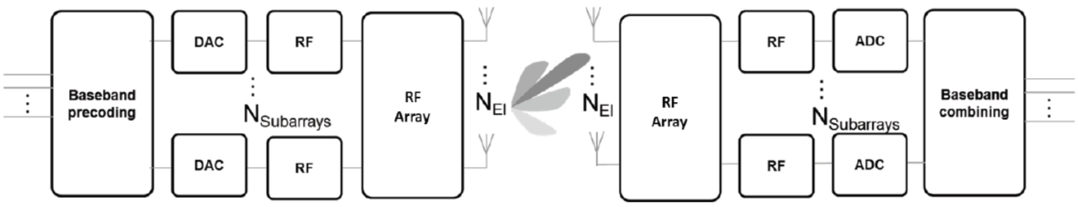

Fig.1 architecture of hybrid beamforming

1.4 system module & beamforming

As consisting of desired destinations node (D),R_i($R_i \geq 1$) relay nodes and a source node (M) shall be our studying such as a wireless relay network.Moreover, the k_R as the vector receive signal with an $N \times N$ beamforming matrix$\mathbf{W} = diag(\mathbf{w})$the relay node $\mathbf{R}i$ should be amplified linearly, where $\mathbf{w} = [w_1, w_2, ..., w_N]$.Beside that as the array steering vectors K beamforming vectors are constructed for the directions of K

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users, therefor for the desired direction where the system always guarantees the maximum beam gain.Furthermore, the desired signal is not changed and by the introduced randomness so only the inter-user interference is affected when, by the side lobes of the beam pattern, the interference is affected by the side lobes of the beam pattern[20].

Additionally, the distributed beamforming is just performed directly to the legal destination via relays in the multiple-relay networks due to, as much as, possible to enlarge the capacity of legal channel[10].Thus, we set $D = \{R1, R2, \cdots, RM\}$,where is the $R1, R2, \cdots, RM$ are the relays in the network and also We define the weight coefficient vector of set D for beamforming as:

$w_R = \left[w_{R_1}^*, w_{R_2}^*, \dots, w_{R_M}^*\right]^T$ then the channel vector from the beamforming is presented as $h_{rd} = \left[h_{R_1D}, h_{R_2D}, \dots, h_{R_MM}\right]^T$ that set to the destination[10].

2. Analysis the results

Here, the consideration for example the number of sites equals to 6 and number users are 6 too. And thus, using simulation by MATLAB the results will obtain for them as shown figures below.

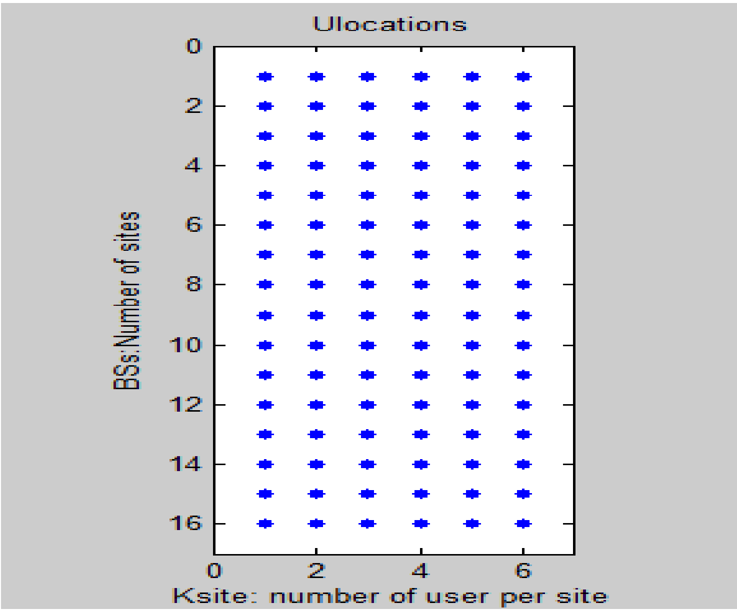

Fig.2 Ulocations of BSs number of sites per number of user per site

Fig.2 represents the Ulocations the BSs(number of sites) per user in each site so we have 16× 6 as grid for massive MIMO.

From figures 3-8 which are presented the relation between gains of number antennas and number of users as outage for filtered channel gains for each sites to study the effect of beamforming that it used. In Fig.3, Fig.4, Fig.5 and Fig.7, the average gain is increased for most of users and it seem to be over 15 dB. But for carefully, we regain take a looking for both figures Fig.6& Fig.8 so they have less than average from previously ,but the sixth site has no more different in its value. Therefore, it means increasing gain that it increases the energy efficiency EE , that is given us a good performances is obtained. And this in meanwhile has effect to increase throughput.

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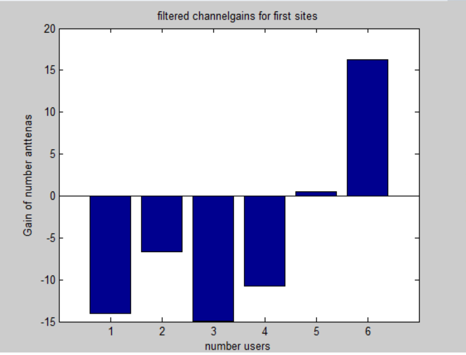

Fig.3 filtered channel gain the first site

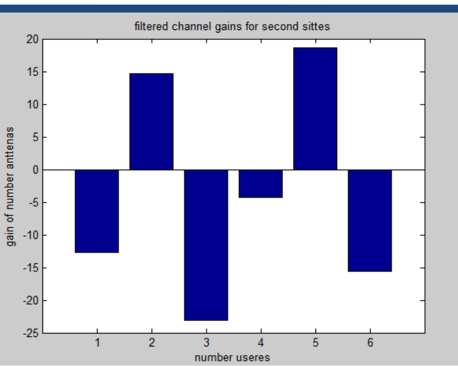

Fig.4 filtered channel gain the second site

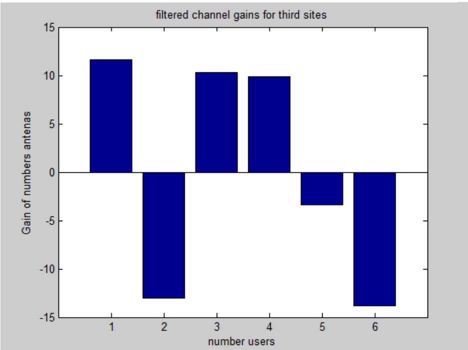

Fig.5 filtered channel gain the third site

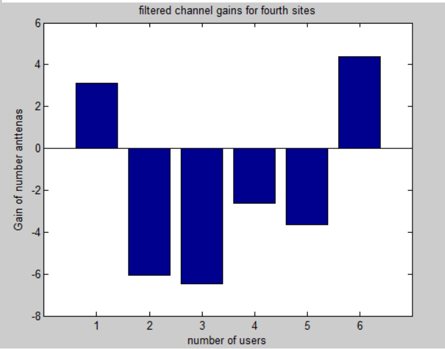

Fig6 filtered channel gain the fourth site

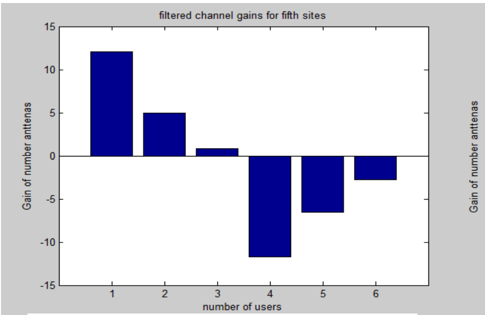

Fig7 filtered channel gain the fifth site

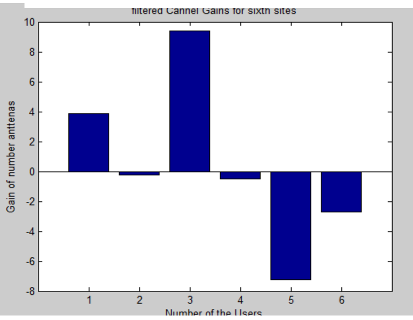

Fig8 filtered channel gain the sixth site

Lastly the figures (9-14) show the MMSE receive beamforming for each site whereby it represents the related between transmit power pUE (in mW) over subcarrier bandwidth and number antennas.

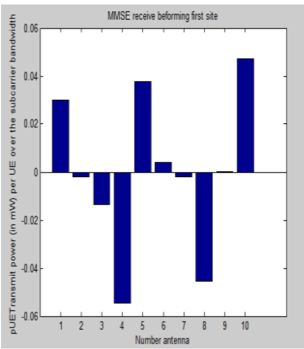

Fig.9 MMSE receive beamforming first site

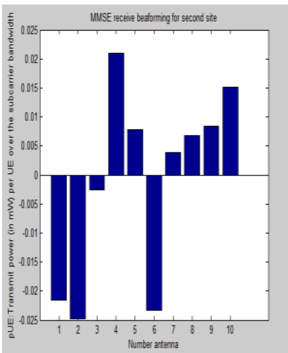

Fig.10 MMSE receive beamforming second site

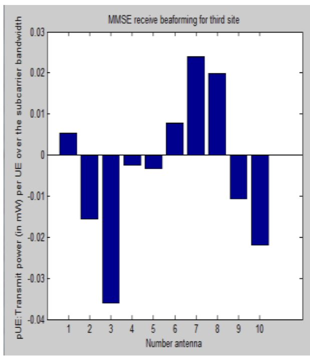

Fig.11 MMSE receive beamforming third site

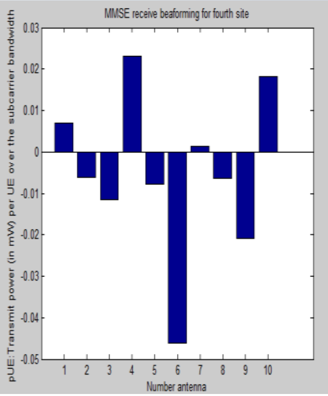

Fig.12 MMSE receive beamforming fourth site

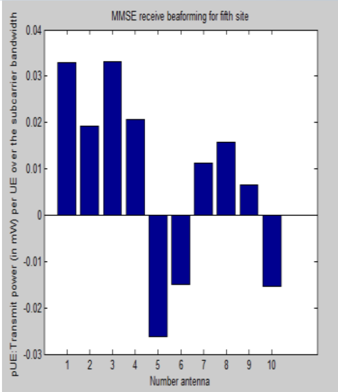

Fig.13 MMSE receive beamforming fifth site

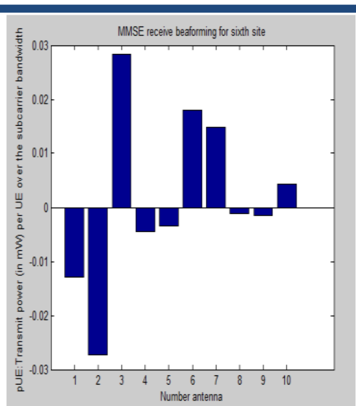

Fig.14 MMSE receive beamforming sixth site

All figures indicate that the average transmit power seem to be very low that its mean introduced the optimal transmission power which guaranteeing spectral efficiency CE . So that, the simplicity should be implemented and also the capacity is increasing due to interference cell is canceled.

3. Conclusion

In this paper, we considered the massive MIMO in the relays network using CSI and enhanced beamforming. The former can be used to obtain the performances as effectives on efficiency the network based on steering beamforming and duty of channel estimation. Thus, more one effective is gotten here where is performance EE & SE that is happened via the getting the optimal transmission power and increasing gain. Moreover, low complexity in design shall be used and capacity also shall increase.

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