Efficient Power Optimization Using MU-MIMO under Non Data Aided Technique

Shashidhar. M
Department of Electronics and Communication Engineering
Vaagdevi College of Engineering
Warangal-05, India
sasi47004@gmail.com

Kishan Rao.K
Department of Electronics and Communication Engineering
Director, Vaagdevi Group of Colleges,
Warangal-05, India.
kishanrao6@gmail.com

Somasekhar Rao. P.V.D.
Department of Electronics and Communication Engineering
JNTU College of Engineering,
Hyderabad, India
pvds_sekhar@hotmail.com

***Abstract* — In wireless communication resources allocation is the major problem when channel is noisy with partial CSI available at transmitter in MIMO (Multiple Input and Multiple Output) under non data aided technique .To overcome this problem MU-MIMO is under taken for consideration. In MU MIMO networks, the spatial degrees of freedom offered by multiple antennas can be advantageously exploited to enhance the system capacity, by scheduling multiple users to simultaneously share the spatial channel. MU-MIMO appears to be affected less by some propagation issues that affect single user MIMO systems. Here many MIMO channels are considered with block fading, where each block is divided into hand shake phase and communication phase. During hand shake phase several orthogonal hand shake signals are transmitted to estimate CSI at the transmitter. In this paper in communication phase a procedure is proposed for optimal allocation of resources and updating of each user resources is being done in round robin fashion.**

***Keywords* — MIMO, MU-MIMO,CSI, power allocation.**

I. Introduction

Emerging trends of wireless communications identifies Multiple-Input Multiple-Output (MIMO) systems to represent the key technology for the development of future generation wireless communication systems. The presence of multiple antennas brings multiple beneficial effects including improved reliability, larger capacity, and enhanced coverage. These benefits can be further exploited together with multiuser diversity gain in Multi User MIMO (MU-MIMO) systems.

To further enhance the performance of wireless communication systems in terms of power efficiency and system throughput. The various system architectures and advanced signal processing techniques are continuously proposed and investigated for both uplink (multiple access channels) and downlink (broadcast channel) transmission. Multiple-Input Multiple-Output (MIMO) systems represent the key technology for the development of future generation wireless communication systems [1], [14]. The presence of multiple antennas brings multiple beneficial effects including improved reliability, larger capacity, and enhanced coverage. These benefits can be further exploited together with multiuser diversity gain in Multi User MIMO (MU-MIMO) systems.

MU-MIMO plays a fundamental role to combat, mitigate, or even annihilate the detrimental effect of interference by benefiting from the features of multi-antenna systems in various forms [15]. Deeper insights on the MU-MIMO potentials require the exploration of multifold directions spanning from channel sounding and modeling to cooperation and cross-layer design via resource allocation, etc[2] [5].

In this paper MU-MIMO is considered with two phase's i.e. hand shake phase and communication phase. In first phase hand shake data is sent to receiver, it estimates the channel depending on the handshake data received. The estimated channel information is fed back to the transmitter depending on the channel state information. The transmitter will decide the power, time and antenna parameters. If the channel state information at the receiver is poor, the antenna parameters are adjusted to improve the data rate as in [3], [4].

Generally the channel state information received at the transmitter plays dominant role in fixing the parameters at the transmitter. But only partial channel state information is generally available at the transmitter [5], [8], [9], [13]. The data rate achieved in turn depends on the feedback from the receiver. The channel estimation is done by each user keeping all other users constants. In this paper, channel is estimated by each receiver in cyclic manner where the resources are increasing to estimate the channel, and an optimum channel estimates is done.

By using channel estimation the optimum handshake data of all the users are decided. To estimate the channel all users can use hand shake data at same time. The handshake data of all users must be orthogonal data. The total block and power of the handshaking data in the multiple users could be greater than the power of the handshaking data in single user system [6], [7], [12]. The efficiency of channel estimation is proportional to the power of the handshake data higher the power of the handshake signal, better will be the channel estimation. Better the channel estimations lower the channel estimation error which should be very less and near to zero [10], [11].

In communication data phase the information arrive at an achievable sum rate expression which in turn depends on channel estimation and communication data parameters obtained in handshake data phase. First the communication parameters of all users are analyzed. Each user receives optimum data in certain directions. The directions of all the users are considered then an procedure is developed such that each user receives maximum sum rate jointly during individual handshake phase and distribution of power among handshake phase and communication data phase in the desired direction results. In section II explains about MU MIMO system with mathematical model taking consideration of block fading. In section III explains about two phases hand shake phase and data phase for various users.

In simulation results we compared MUMIMO system for various users such as comparison for different block lengths and different SNRs.

II. System Model

In a cellular system consists of multiple users, each user with multiple transmit antennas can access the receiver with multiple receiving antennas. The channel between the user ‘a’ and the receiver is estimated by a Matrix ‘B_a’ of order $m_R \times m_T$. m_R represents the no of antennas at receiver m_T represents the no of antenna at transmitter.

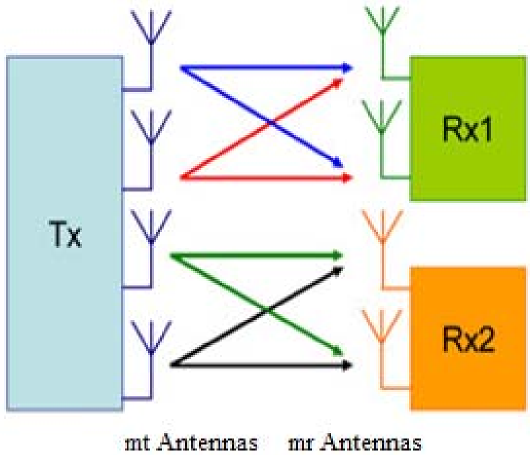

Fig1: Multi user MIMO Block Diagram

The channel is constant for a group of symbol ‘S’ and modify to a realization at the end of the block which is termed as Block Fading. The receiver executes a linear MMSE estimation to estimate the channels during Handshake Phase in which S_h symbols are transmitted out of ‘S’ symbols , the remaining S_c symbols (S_c= S- S_h) belong to commutation data.

The transmitter has the statistical model of the channel while the receiver has noisy estimate of fading channel .Each transmitter send a vector v_{at} the received vector at time ‘t’ is given by

$$R_t = \sum_{a=1}^{A} B_a v_{at} + g_t \quad t = 1, \dots\dots S \qquad (1)$$

Where A – no of users

g_t - Zero mean, identify covariance complex Gaussian vector at time ’t’.

B_a- Complex Gaussian random variable each user has a power constraint

$$P_a = \frac{1}{S} E\left[\sum_t v_{at}^{*} v_{at}\right]$$

Average over ‘S’ symbols

Each transmitter has statistical model of the channel i.e. partial CSI with covariance feedback in which each transmitter know the channel covariance information of all transmitters. The receiver is assumed to have any physical restriction and the antenna elements of the receiver are sufficiently spaced such that the signals received at different antenna elements are uncorrelated. Correlation exists among the transmitted signals by different antenna elements from single user model, the channel can be written as

$$B_a = Z_a C_a^{\frac{1}{2}} \qquad (2)$$

Where elements of Z_a are zero mean, unit variance complex Gaussian random variable. We will call C_a as channel covariance feed back matrix of user ‘a’.

III. Joint Optimization

The block of ‘S’ symbols is divided in to two groups Handshake phase symbols and Communication data symbols. During the handshake phase, each user has S_a handshake signal, with handshake signal power P_{ha} and Handshake signal power duration S_h.During communication data phase , each user has communication data power P_{ca} which appears as a limitation on trace of transmit covariance matrix. The goal is to find the optimum values of these Handshake and communication data parameters.

A. *Handshake and channel estimation:*

During the handshake phase the Input – output relationship of a multiple access channel is given by

$$Y_h = \sum_{a=1}^{A} B_a T_a + N_h \qquad (3)$$

Where T_a is $m_T \times S_h$ dimensional Handshake signal user ‘a’ Y_h and N_h are $m_R \times S$ dimensional receiver and noise matrices. The ‘t’th column of matrix equation in (3) represents input output relationship at time ‘t’. The power constraint for handshake input signal for user ‘a’ is $\frac{1}{S_h} tr(TT^{*}) \le P_{ha}$. The receiver with the knowledge of all Handshake symbol is suppressed to estimate the channels of all users during same handshaking phase. Multi user channel is represented as single user channel by stacking

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all the channel matrices and Handshake signal matrices of all users. Hence if can be written as

$$Y_h = \bar{B}\bar{H} + Nh \quad (4)$$

Where $\bar{B} = [B_1, \ldots\ldots, B_A]$ is a $m_R \times A_{m_T}$ dimensional channel matrix

$$\bar{T} = [T_1^{\prime} T_2^{\prime} \ldots\ldots\ldots T_A^{\prime}]^{\prime} \text{ is an } A_{m_T} \times S_h$$

Dimensional Handshake singed matrix longer rows are formed by placing channel matrices next to each other longer columns are formed by placing handshaking symbols on top of each other. The receiver will estimate $\bar{B}$ using the output Y_h and handshake signal $\bar{T}$. The elements in a row B_a are correlated and elements in a columns of B_a are uncorrelated for each user, row ***i*** of the channel matrix is with row j. This also hold for stacked matrix $\bar{B}$. Let us represent row of B_a as $b_{ai}^{\prime}$ where

$E[b_{ai} b_{ai}^{\prime}] = C_a,\ i = 1, \ldots\ldots, m_R$ and row i of $\bar{B}$ as $\bar{b}_i = [b_{1i}^{\prime} \ldots\ldots b_{Ai}^{\prime}]$,

where $\bar{C} = E[\bar{b}_i \bar{b}_i^{\prime}] = Diag[C_1, \ldots\ldots, C_A]$, is a block diagonal matrix having C_a on its diagonals.

Let the given value representation of channel covariance matrix of user 'a' be

$$C_a = U_{C_a} D_{C_a} U_{C_a}^{\prime}$$

Then the given vectors of stacked channel covariance matrix $\bar{C} = \bar{U}_c \bar{D}_c \bar{U}_c^{\prime}$ can also be written as $\bar{U}_c = diag\{\bar{U}_{c_1}, \ldots\ldots, \bar{U}_{c_A}\}$ which is also a block diagonal matrix.

A row of $\bar{B}$ is formed by combining the rows of all B_a in to a single and longer row, it can conclude that rows of $\bar{B}$ are also and receiver can estimate each of them independently using the same handshaking symbols. The i^{th} row of (4) which represents the received signals at the i^{th} antenna of the receiver over the handshaking duration can be written as

$$R_{hi} = \bar{T}^{\prime}\bar{b}_i + g_{hi} \quad (5)$$

The MMSE estimation results can be used since it is equivalent to exception of a block diagonal channel covariance matrix using single user channel estimation. The estimate of $\bar{b}_i$ is denoted by $\hat{\bar{b}}_i = MR_{hi}$ and Channel estimation error as $\tilde{b}_i = \bar{b}_i - \hat{\bar{b}}_i$ optimum MMSE estimator can be found $M^* = \bar{C}\bar{T}(\bar{T}^{\prime}\bar{C}\bar{T} + I)^{-1}$

Mean Square error becomes

$$\min_{M} E\left(\tilde{b}_i^{\prime} \tilde{b}_i\right) = tr\left((\bar{C}^{-1} + \bar{T}\bar{T}^{\prime})^{-1}\right) (6)$$

Optimum Handshake signal $\bar{T}^*$ can be choose to minimize the mean square error of the channel estimation.

B. Procedure:-

For a given handshake power and handshake duration, the following procedure finds $\bar{T}^*$ and $\bar{T}_a^*$, hand shake signals of individual uses for $C_a = U_{C_a} D_{C_a} U_{C_a}^{\prime}$, P_{ha}, S_h and power constraints $tr(T_a T_a^{\prime}) \le P_{ha} S_h$, the $A_{m_T} \times S_h$ dimensional optimum stacked handshake signal $\bar{T}^*$ that minimizes the power of channel estimation error is $\bar{T}^* = \bar{U}_c \bar{D}_T^{-1/2}$ and $m_T \times A$ dimensional optimum handshaking signal of user 'a' is

$$T_a^* = [0, \ldots\ldots, 0, U_{C_a} D_{T_a}, 0, \ldots\ldots, 0]$$

With

$$\lambda_{ai}^T = \left[\frac{1}{\sigma_a^T} - \frac{1}{\lambda_{ai}^C}\right], i = 1, \ldots\ldots, \min(m_T, S_{h_a}) \ (7)$$

Where $(\sigma_a^T)^2$ is the Lagrange multiplier that satisfies the power constraint with $\sigma_a^T = \frac{I_a}{P_{ha} + \sum_{i=1}^{I_a} \frac{1}{\lambda_{ai}^C}}$ and I_a is largest index that has non zero λ_{ai}^T for user 'a'.

Assume that we have $\bar{T} = \bar{U}_T \bar{D}_T^{-1/2} \bar{L}_T^{\prime}$ the equation in (5) is reduced when $\bar{C}^{-1}$ and $\bar{T}\bar{T}^{\prime}$ have same eigen vectors. Therefore, $\bar{U}_T = \bar{U}_c$ Since $\bar{T}\bar{T}^{\prime} = \bar{U}_T \bar{D}_T \bar{D}_T^{\prime}$ and unitary matrix $\bar{L}_T$ will not appear in objective function and the constraint. We can select $\bar{L}_T = I$. Now we have

$$\bar{T} = \bar{U}_c \bar{D}_h^{1/2} \ (8)$$

$$\begin{bmatrix} T_1 \\ \vdots \\ T_A \end{bmatrix} = \begin{bmatrix} U_{C_1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & U_{C_A} \end{bmatrix} \begin{bmatrix} D_{S_1}^{\frac{1}{2}} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & D_{S_A}^{\frac{1}{2}} \end{bmatrix} (9)$$

Where each user has $T_a = [0, \ldots\ldots, 0, U_{C_a} D_{T_a}^{1/2}, 0, \ldots\ldots, 0]$

T_a is an $m_T \times S_h$ with dimensional matrix and U_{Ca} is an $m_T \times m_T$ dimensional matrix. The dimensions of D_{ha} is denoted by $m_T \times S_{h_a}$ in such a way that $\sum_{a=1}^{A} S_{h_a} = S_h$ Inserting $\bar{T}$ in to (5) the optimation problem can be written

$$\tilde{\delta}_{sum} = \min_{\substack{tr(D_{T_a} \le P_{h_a} S_{h_a}) \\ a=1,\ldots\ldots,A}} \sum_{a=1}^{A} tr\left(\left(\overline{D}_{c_a}^{-1} + \overline{D}_{T_a}\right)\right) (10)$$

The lagrangian of eq(10) can be written as

$$\sum_{a=1}^{A} \sum_{i=1}^{m_T} \frac{1}{\frac{1}{\lambda_{ai}^C} + \lambda_{ai}^T} + \sum_{a=1}^{A} (\sigma_a^T)^2 \left(\sum_{i=1}^{m_T} \lambda_{ai}^T - P_{h_a} S_{h_a}\right) (11)$$

Where $(\sigma_a^T)^2$ are lag ranges multipliers the convex function of λ_{ai}^T, is lagrangian, the unique optimum solution is the solution that satisfies the condition. The available power of each user is water filling over the Eigen values of its own channel covariance matrix. In order to compute σ_a^T we sum both sides of (7) over all antennas to get

$$\sigma_T = \frac{J_a}{P_{ha} + \sum_{i=1}^{J_j} \frac{1}{\lambda_i^C}}$$

Where J_a is largest index that has non zero λ_{ai}^T. As in single user case, for any P_{h_a}, increase and $S_{h_a} > t_s$ increasing S_{h_a} will not give better channel estimates. For big S_{h_a}, communication data length will decrease which in turn decrease the achievable rate of communication data phase. Hence S_{h_a} can be less or equal to t_s i.e. $S_{h_a} \leq t_s$ few dimensions of channels will be estimated for each user due to constraint on handshake duration. The handshake duration in multi user is not equal to know of user multiples by handshake duration for single user since handshake duration should be less than length of block hence, the duration of handshake in multiuser is less than duration of handshake in single user.

Since the total power is same Handshake power will be higher for a shorter handshake duration Channel estimate will be better and channel estimation error will be less for higher Handshake power some dimensions of the channel are estimated and hence, the channel estimation error will be less for those estimated dimensions. If the no of users does not limit the degree of freedom for MAC, the no of receiving antennas will decide the degree of freedom. In this the degree of freedom is limited by handshake phase duration which in turn depends on many variable including no of receiving antennas. The procedure explains that are all user in a multi user system are orthogonal in time domain.

All the channels are stacked by receiver to calculated channel estimation. As a result of stacking, channel covariance matrix is blocking diagonal. This is equivalent to a single user with many transmitting antennas, which are grouped into a group. The group is uncorrelated, but each group is correlated with in the group which gives to a block diagonal channel covariance matrix since this is same as single user problem, handshake signals of different users are orthogonal in time. The user 'a' transmits handshake signal during its own time slot for S_{h_a} channel user. σ_a^T is a function of P_{h_a} and S_{h_a} are chosen such a way that increases the sum rate of communication data phase. The value of S_{h_a} gives the total no of available channels parallel to user 'a', P_{h_a} is used to determine no of channel that will be estimated. Sum rate formula has both parameters P_{h_a} and S_{h_a} which in used turn used to compute T_a^*. Next we will determine the eigen values of covariance matrices of estimated channel vector for all users. The covariance matrix of channel estimation error of user 'a' can be found by $\tilde{C}_a = U_{C_a}\left(D_{C_a}^{-1} + D_{T_a}\right)^{-1} U_{C_a}'$ where $\tilde{\lambda}_{ai}^C = min(\lambda_{ai}^C, \sigma_a^T)$ are Eigen values.

The covariance matrix of estimated channel of user a can be found using the orthogonality principle as

$$\hat{C} = \overline{U}_C \left(\overline{D}_C - \tilde{D}_C \right) \overline{U}_C'$$

Where $\hat{\lambda}_{ai}^C = max(\lambda_{ai}^C - \sigma_a^T, 0)$ are eigen values.

C. Data Transmission Phase:

The multiple Access channel sum – rate can be calculated using the input matrices and arrayed channel so we can express (1) as

$$R = \sum_{a=1}^{A} \hat{B}_a v_a + \sum_{a=1}^{A} \tilde{B}_a v_a + t = \hat{B}\bar{v} + \tilde{B}\bar{v} + t \quad (12)$$

Where $\hat{B} = [\hat{B}_1, \ldots\ldots \hat{B}_a]$, $\tilde{B} = [\tilde{B}_1, \ldots\ldots \tilde{B}_a]$,

Where $m_R \times A_{m_T}$ dimensional, $\bar{v} = [v_1', \ldots\ldots, v_A']'$ for knowing optimum input distribution we calculated lower bound with Gaussian $\bar{v}$,

$$W_{lb}^{sum} = I(R ; \bar{v}|\hat{B}) \geq E_{\hat{B}}\left[\log\left|I + Y_{\tilde{B}v+t}^{-1} \hat{B}\bar{Q}\hat{B}'\right|\right] \quad (13)$$

Where $Y_{\tilde{B}v+t}$ is covariance matrix of the noise $\tilde{B}\bar{v} + t$ and $\bar{Q} = E[\bar{v}\bar{v}']$ But the inputs of different users are independent to each other, $\bar{Q}$ is a block diagonal matrix of Q_a having power constraint $tr(Q_a) \leq P_{C_a}$ we have seen $\hat{B}\bar{Q}\hat{B}' = \sum_{a=1}^{A} \hat{B}_a Q_a \hat{B}_a'$ The covariance of effective noise can be computed as $Y_{\tilde{B}v+t} = I + \sum_{a=1}^{A} E_{\tilde{B}_a}[\tilde{B}_a Q_a \tilde{B}_a']$ but $[\tilde{B}_a Q_a \tilde{B}_a'] = tr(Q_a \tilde{C}_a) I$ our intention is finding largest rate that is needed with Gaussian signaling maximization of (13) over the block is

$$Y_{Su} = \max_{\substack{(Q_a, P_{h_a}, S_{h_a}) \in T_a \\ tr(Q_a) \leq P_{C_a}, \forall a}} S_C E_{\hat{B}_a}\left[\log\left| I \frac{\sum_{a=1}^{A} \hat{B}_a Q_a \hat{B}_a'}{1 + \sum_{a=1}^{A} tr\left(Q_a \tilde{C}_a\right)}\right|\right] (14)$$

Where $T_a = \{(Q_a, P_{h_a}, S_{h_a}) | tr(Q_a) S_c + P_{h_a} S_{h_a} = P_a S\}$

And S_c determines the amount of time that is consumed during hand shake phase.

Where P_{h_a}, S_{h_a} is hand shake parameter of user 'a' and Q_a is Data Communication parameter and these are decomposed into Eigen values and Eigen vectors. Eigen vectors determine director of Transmission and Eigen values determines the power in corresponding Transmit direction.

D. Directions of Transmissions:

At the receiver, when the channel state information is perfect, the Eigen vectors of channel covariance matrix are equal to Eigen vectors of Transmit covariance matrix. i.e., $U_{Q_a} = U_{C_a}$ .In the below shown theorem if follows the above principle when the channel estimation is not perfect i.e. error at the receiver.

E. Procedure 2:

The Spectral decomposition of covariance matrix of channel is assumed to be $C_a = U_{C_a} D_{C_a} U_{C_a}^{\dagger}$ of user 'a'. The Corresponding optimum transmit covariance matrix Q_a is $Q_a = U_{C_a} D_{C_a} U_{C_a}^{\dagger}$ for user 'a'. The optimization problem in (14) can be specified using Theorem 2 as

$$Y_{Sum} = \max_{\substack{(\lambda_a^Q, P_{h_a}, S_{h_a}) \in P_a \\ a=1,\dots,A}} S_c E_{\hat{z}_{ai}} \left[\log \left| I + \frac{C_a \sum_{i=1}^{m_T} \lambda_{ai}^Q \hat{\lambda}_{ai}^C \hat{z}_{ai} \hat{z}_{ai}'}{1 + C_a \sum_{i=1}^{m_T} \lambda_{ai}^Q \tilde{\lambda}_{ai}^C} \right| \right] \quad (15)$$

Where $\hat{z}_{ai}$ is $m_R \times 1$ dimensional identity – covariance zero – mean Gaussian random vector is i^{th} column $\hat{z}_{ai}$, $\lambda_a^Q = \left[\lambda_{a1}^Q, \dots\dots, \lambda_{am_T}^Q\right]$ and $P_a = \{(\lambda_a^Q, P_{h_a}, S_{h_a}) | (\sum_{i=1}^{m_T} \lambda_{ai}^Q) S_c + P_{h_a} S_{h_a} = P_a S\}$

F. Policy of Allocating Power:

When there is perfect CSI at the receiver and partial CSI at transmitters, for a Multi – input Multi output system, a new algorithm is proposed tom fond the optimum power. Existence of P_{h_a} and S_{h_a} violates the symmetry as this algorithm cannot be applied for finding these values.

By inserting $\hat{\lambda}_{ai}^C$ and $\tilde{\lambda}_{ai}^C$ into (15) and assuming $\lambda_{ai}^Q for i = J_a + 1, \dots\dots, m_T$, there the update of each user for optimization problem becomes

$$Y_{Sum}^a = \max_{(\lambda_a^Q, P_{h_a}, S_{h_a}) \in P_a} S_c E \left[\log \left| \Phi + \frac{\sum_{i=1}^{J_a} \lambda_{ai}^Q (\lambda_{ai}^C - \sigma_a^T) \hat{z}_{ai} \hat{z}_{ai}'}{\gamma + \sigma_a^T P_{c_a}} \right| \right] \quad (16)$$

Where $\Phi = I + \frac{\sum_{l \neq a}^{A} \sum_{i=1}^{J_l} \lambda_{li}^Q (\lambda_{li}^C - \sigma_l^T) \hat{z}_{li} \hat{z}_{li}'}{1 + \sum_{l=1}^{A} \sigma_l^T P_{c_l}}$ and $\gamma = 1 + \sum_{l \neq a}^{A} \sigma_l^T P_{c_l}$ thus the optimization problem in (16) has become a problem of single user with constant interference from other users. For any pair (P_{h_a}, S_{h_a}), it shows that $J_a < S_{h_a}$, there is also another pair (P_{h_a}, S_{h_a}) that shows higher rate but it is enough for $J_a = S_{h_a}$. We can write (16) as

$$Y_{Sum}^a = \max_{(\lambda_a^Q, P_{h_a}, S_{h_a}) \in Y_a} S_c E \left[\log \left| \Phi + \frac{\sum_{i=1}^{S_{h_a}} \lambda_{ai}^Q (\lambda_{ai}^C - \sigma_a^T) \hat{z}_{ai} \hat{z}_{ai}'}{\gamma + \sigma_a^T P_{c_a}} \right| \right] \quad (17)$$

Where $Y_a is \{(\lambda_a^Q, P_{h_a}, S_{h_a}) | (\sum_{i=1}^{m_T} \lambda_{ai}^Q) S_c + P_{h_a} S_{h_a} = P_a S\}$, $P_{h_a} > \sum_{i=1}^{S_{h_a}} \left(\frac{1}{\lambda_{aS_{h_a}}^C} - \frac{1}{\lambda_{ai}^C}\right)$ and the condition $P_{h_a} > \sum_{i=1}^{S_{h_a}} \left(\frac{1}{\lambda_{aS_{h_a}}^C} - \frac{1}{\lambda_{ai}^C}\right)$ guarantees that, using the pair (P_{h_a}, S_{h_a}), all S_{h_a} channels are filled, i.e., $J_a = S_{h_a}$. The parameters which are optimized using (17) are discrete value S_{h_a}, and continuous valued P_{h_a} and λ_{ai}^Q for $i = 1, \dots\dots, S_{h_a}$. As S_{h_a} is discrete, $1 \leq S_{h_a} \leq m_T$, we perform search over S_{h_a} and solve m_T reduced optimization problems with fixed S_{h_a} in each one. The maximum rate solution is

$$Y_{Sum}^a = \max_{1 \leq S_{h_a} \leq m_T} Y_{Sum}^{a, S_{h_a}} \quad (18)$$

For $i = 1, 2, \dots\dots, S_{h_a}$. Here the inner optimization problem becomes

$$Y_{Sum}^{a, S_{h_a}} = \max_{(\lambda_a^Q, S_h) \in Y_a, S_{h_a}} S_c E \left[\log \left| + \sum_{i=1}^{S_{h_a}} \lambda_{ai}^Q g_{ai}(S_{h_a}) \hat{z}_{ai} \hat{z}_{ai}' \right| \right] \quad (19)$$

Where $g_{ai}(S_{h_a}) = \frac{(\lambda_{ai}^C - \sigma_a^T)}{\gamma + \sigma_a^T P_{c_a}}$ But $S_{h_a} + 1$ variables that are optimum has $\lambda_{a1}^Q, \lambda_{a2}^Q, \dots\dots \lambda_{aS_{h_a}}^Q$ and P_{h_a}. An affine $g_{ai}(S_{h_a})$ can be shown from equation (19) as concave when $S_{h_a} = 1$. The solution for the first order necessary conditions will give a local maximum. The lagrangian for Optimization problem in (19) is where σ_a is Lagrange multiplier.

The conditions are viewed as

$$\frac{S_c}{S} g_{ai}(S_{h_a}) E\left[\hat{z}_{ai} J^{-1} \hat{z}_{ai}'\right] \leq \sigma_a S_c, i = 1, 2, \dots\dots, S_{h_a} \quad (20)$$

$$\frac{S_c}{S} \sum_{i=1}^{S_{h_a}} \lambda_{ai}^Q E\left[\hat{z}_{ai}' J^{-1} \hat{z}_{ai}\right] \frac{\partial g_{ai}(S_{h_a})}{\partial S_{h_a}} = \sigma_a S_{h_a} \quad (21)$$

Where $J = \Phi + \sum_{i=1}^{S_{h_a}} \lambda_{ai}^Q g_{ai}(S_{h_a}) \hat{z}_{ai} \hat{z}_{ai}'$ for upgrading Eigen values and handshake power of user 'a', we proposed algorithm, that is

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$$P_{h_a}(t+1) = \sum_{l=1}^{S_{h_a}} \lambda_{al}^{Q}(t) \frac{g'_{al}(P_{h_a}(t+1))}{g_{al}(P_{h_a}(t+1))} = \frac{S_{h_a}}{S_c} \quad (22)$$

$$\lambda_{al}^{Q}(t+1) = \frac{\lambda_{al}^{Q}(t) g_{al}(P_{h_a}(t+1)) E[\hat{g}'_{al} J^{-1} \hat{g}_{al}]}{\sum_{j=1}^{S_{h_a}} \lambda_{aj}^{Q}(t) g_{aj}(P_{h_a}(t+1)) E[\hat{g}'_{aj} J^{-1} \hat{g}_{aj}]} P_c \quad (23)$$

Where $P_c = \frac{(P_a S - P_{h_a}(t+1) S_{h_a})}{S_c}$

The solution of inner optimization problem in (19) in terms of training power P_{h_a} and Eigen values of transmit covariance matrix $\lambda_{a1}^{Q}, \lambda_{a2}^{Q}, \dots, \lambda_{aS_{h_a}}^{Q}$ of user 'a' when P_{h_a} and remaining parameters are fixed can be found using this algorithm.m_T Such algorithms can be run simultaneously for user 'a' .But solution can be taken as the one that results in maximum rate, which gives us value of S_{h_a} that maximizes equation (18). The parameters $\lambda_{a}^{Q}, P_{h_a}, S_{h_a}$, that maximize (18) are known, when rest of users are fixed. In this fashion we iterate over all users finally we get optimum parameters of all users maximizing equation (16).

IV. SIMULATION RESULTS

By seeing above mentioned mathematical analysis, with our proposed procedures, we observed that it always converges. Let us consider MIMO systems with $m_T = 2$, $m_R = 2$ and SNR is 20dB, S =5 .In fig 1 & 2 we drawn Eigen values of data communication matrix and handshake power with respect to no. of iterations for possible values of hand shake signal duration for 2 systems .In fig 2 we drawn Eigen values of data for SNR = 40 db by observing fig 1. We can say that data rate is large when hand shake duration is one symbol period for S = 5. Hence for known system parameters we can estimate one dimension is optimum. By increasing average power we draw the graph for same length S=5 in that the data rate with 2 symbol handshake duration is high than hand shake with one symbol duration.

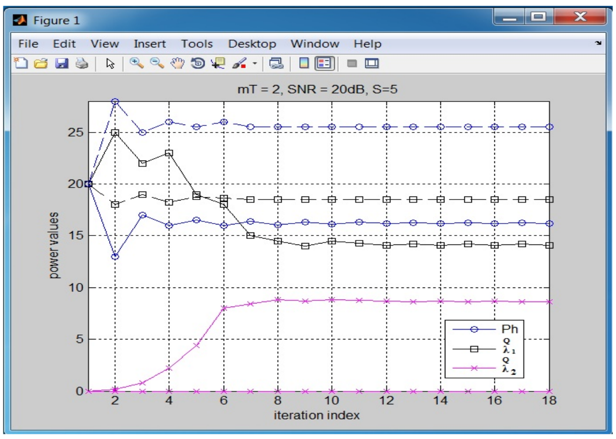

Fig.2 power allocation and Eigen directions are plotted dashed Curves corresponds to 1 symbol hand shake duration .Solid curve Corresponds to 2 symbol hand shake duration

If we repeat this for various combinations of MIMO Systems we observe that with small block duration training many user s hand shake phase require large power values. Now we will see the effect of block duration by observing the fig.3.

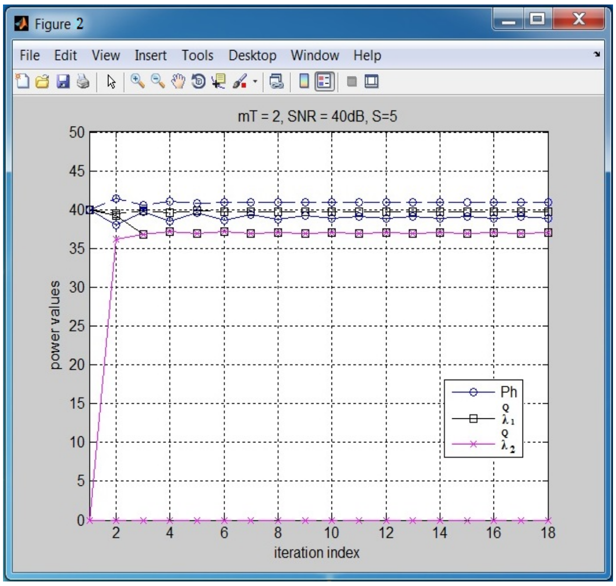

Fig.3 power allocation and Eigen directions are plotted dashed Curves corresponds to 1 symbol hand shake duration .Solid curve Corresponds to 2 symbol hand shake duration

In fig3 we considered MIMO Systems with $m_r = 2$, $m_t=2$ p= 20db S=25 by observe fig 1 and fig3 we can say that the data rate with 2 symbol hand shake duration is larger than 1 symbol hand shake duration.

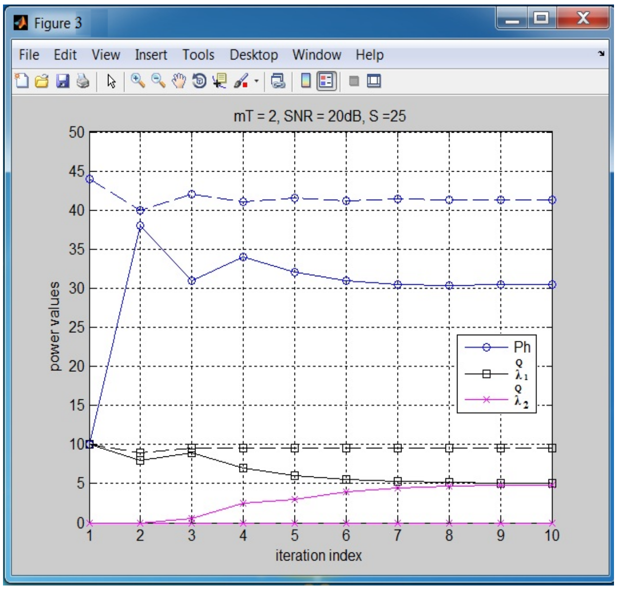

Fig.4 power allocation and Eigen directions are plotted dashed Curves corresponds to 1 symbol hand shake duration .Solid curve Corresponds to 2 symbol hand shake duration

From fig 1, 2, 3 we can say that if power and block duration is small, then. We can estimate channel in only one direction. Either increasing power level or block duration. We can estimate channel in multiple directions. Next we will observe estimations for various covariance matrices. Let us consider 2 systems with $m_T = 2, m_R = 2$ average power p=20db. In first system one Eigen value is stronger than other in second system both Eigen direction values are same. Now first system estimates drawn in fig 4 &5.

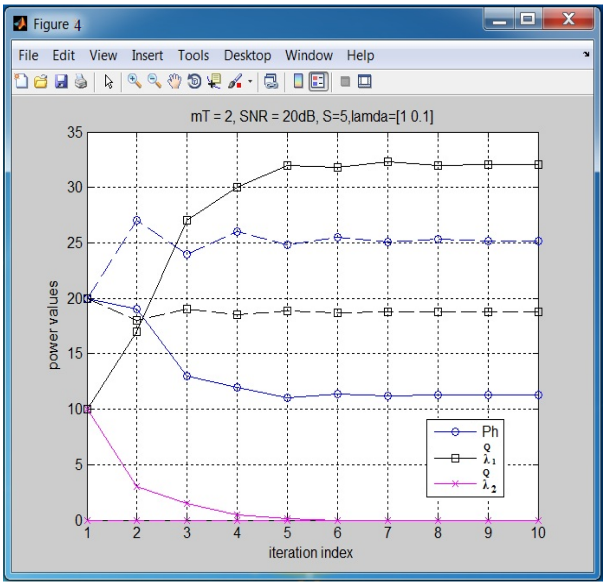

Fig.5 power allocation and Eigen directions are plotted dashed Curves corresponds to 1 symbol hand shake duration .Solid curve Corresponds to 2 symbol hand shake duration

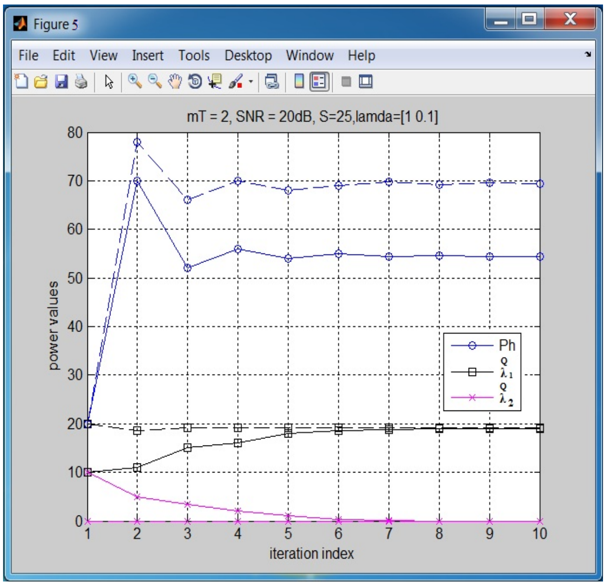

Fig.6 Power allocation and Eigen directions are plotted dashed Curves corresponds to 1 symbol hand shake duration .Solid curve Corresponds to 2 symbol hand shake duration

If we observe fig 4 and fig5 the block duration is increased the estimation of second direction is not useful In fig 5 and 6 we drawn for various block duration 5 & 25 for the second system, as the block duration is increased the data rate is high with 2 symbol hand shake duration comparing with low block duration.

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V. Conclusion

In this paper the covariance feedback is observed for block fading MU-MIMO and at transmitted information is transmitted with available partial CSI, Every transmission data block consist of two phases, one is hand shake phase, another is communication phase. During handshake phase, orthogonal hand shake signal are transmitted for training where as communication phase, optimized sum rate is achieved and power optimization is observed for all users

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