Asian Journal of Applied Science and Technology (AJAST)

Volume 1, Issue 6, Pages 53-57, July 2017

Enhancing Sum Rate Capacity Using Scheduling Algorithm

M.Nithya[1] and S.Jayalakshmi[2]

[1]*Bachelor of Engineering, Department of Electronics and Communication Engineering, IFET College of Engineering, Villupuram, India.*
[2]*Associate Professor, Department of Electronics and Communication Engineering, IFET College of Engineering, Villupuram, India.*

Article Received: 27 June 2017 *Article Accepted: 10 July 2017* *Article Published: 16 July 2017*

ABSTRACT

In wireless communication the major problem is data rate, in this project we are using scheduling algorithms for increasing the sum rate capacity. We are using two types of algorithms namely zero-forcing beam forming algorithm and semi-orthogonal user scheduling algorithm for increasing the sum rate capacity of a system. We use a MIMO broadcast system in which we are going to increase the sum rate capacity of the system. Zero-forcing Beam forming (ZF-BF) is a spatial signal processing in multiple antenna wireless devices. For downlink, the ZF-BF algorithm users together with nulling out the directions to undesired users and for uplink, ZF-BF receives from the desired users together with nulling out the directions from the interference users. The concept of interference users in the receive mode is information theoretically dual to undesired users in the transmit mode. If the transmitter knows the downlink channel status information perfectly, ZF-based pre coding can achieve close to the optimal capacity especially when the number of users is sufficient. With limited channel state information at the transmitter, ZF-BF requires the amount of feedback overhead proportional to the average signal –to-noise ratio (SNR) to achieve the full multiplexing gain. Semi-orthogonal user scheduling algorithm is used to increase the speed of the system and to schedule the users and to allocate time for them to transmit data between many users. By doing so we are able to eliminate the interference among users and SINR (Signal to Interference Noise ratio) is reduced. The feedback bits are also fixed which reduces the feedback overload.

Keywords: Wireless communication, Data rate and Transmitter.

1. INTRODUCTION

MIMO is an antenna technology for wireless communication in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communication circuits are combined to minimize errors and optimize data speed. The use of multiple antennas at the transmitter and receiver in wireless systems, popularly known as MIMO (Multiple input multiple output) technology, has rapidly gained in popularity over the past decade due to its powerful performance-enhancing capabilities. Communication in wireless channels is impaired predominantly by multi-path fading. Multipath is the arrival of the transmitted signal at an intended receiver through differing angles and/or different time delays and/or differing frequency (i.e., Doppler) shifts due to scattering of electromagnetic waves in the environment. Consequently, the received signal power fluctuates in space (due to angle spread) and/or frequency (due to delay spread) and/or time (due to Doppler spread) through the random superposition of the impinging multipath components. This random fluctuation in signal level, known as fading, can severely affect the quality and reliability of wireless communication. Additionally, the constraints posed by limited power and scarce frequency bandwidth make the task of designing high data rate, high reliability wireless communication systems extremely challenging. MIMO technology constitutes a breakthrough in wireless communication system design. The technology offers a number of benefits that help meet the challenges posed by both the impairments in the wireless channel as well as resource constraints. In addition to the time and frequency dimensions that are exploited in conventional single-antenna (single-input single-output) wireless systems, the leveraging of MIMO are realized by exploiting the spatial dimension (provided by the multiple antennas at the transmitter and receiver).

The advantages of multiple-input multiple-output (MIMO) systems have been widely acknowledged, to the extent that certain transmit diversity methods have been incorporated into wireless standards. Although transmit diversity is clearly advantageous on a cellular base station, it may not be practical for other scenarios specifically, due to size, cost, or hardware limitations, a wireless agent may not be able to support multiple transmit antennas. Example includes most handsets (size) or the nodes in a wireless sensor network (size, power).

2. EXISTING SYSTEM

Multi-user MIMO offers big advantages over conventional point-to-point MIMO: it works with cheap single-antenna terminals, a rich scattering

Volume 1, Issue 6, Pages 53-57, July 2017

environment is not required, and resource allocation is simplified because every active terminal utilizes all of the time-frequency bins. However, multi-user MIMO, as originally envisioned, with roughly equal numbers of service antennas and terminals and frequency-division duplex operation, is not a scalable technology Massive MIMO (also known as large-scale antenna systems, very large MIMO, hyper MIMO, full-dimension MIMO, and ARGOS) makes a clean break with current practice through the use of a large excess of service antennas over active terminals and time-division duplex operation. Extra antennas help by focusing energy into ever smaller regions of space to bring huge improvements in throughput and radiated energy efficiency. Other benefits of massive MIMO include extensive use of inexpensive low-power components, reduced latency, simplification of the MAC layer, and robustness against intentional jamming. The anticipated throughput depends on the propagation environment providing asymptotically orthogonal channels to the terminals, but so far experiments have not disclosed any limitations in this regard. While massive MIMO renders many traditional research problems irrelevant, it uncovers entirely new problems that urgently need attention: the challenge of making many low-cost low-precision components that work effectively together, acquisition and synchronization for newly joined terminals, the exploitation of extra degrees of freedom provided by the excess of service antennas, reducing internal power consumption to achieve total energy efficiency reductions, and finding new deployment scenarios[1].In heterogeneous networks (HetNets), low-cost small cells referred to as pico or femto cells are flexibly deployed in order to provide dense coverage and ubiquitous high throughput. The use of massive MIMO in coordination with HetNets in order to provide improved interference management and energy efficiency is an important future research direction.[2] In cellular systems, user throughput estimation is needed for cell-site selection, handover design, etc. So long-term average user throughput estimation methods are used for the proportional fair (PF) scheduling algorithm under multiple-input multiple-output (MIMO) channel environments. From the observation that the current data rate divided by the long-term average throughput of each user is roughly around a similar level, we propose estimation methods for both single user MIMO (SU-MIMO) and simple multiuser MIMO (MU-MIMO) scheduling scenarios. Since their throughput estimation methods do not depend on the statistics of other users' data rates, they can be easily implemented in practical systems regardless of user data rate distribution. [3]

Massive MIMO is a variant of multiuser MIMO where the number of base-station antennas M is very large (typically 100) and generally much larger than the number of spatially multiplexed data streams (typically 10). The benefits of such an approach have been intensively investigated in the past few years. Unfortunately, the front-end A/D conversion necessary to drive hundreds of antennas, with a signal bandwidth of the order of 10 to 100 MHz, requires very large sampling bit-rate and power consumption. In order to reduce complexity, Hybrid Digital-Analog architectures have been proposed. Our work in this paper is motivated by one of such schemes named Joint Spatial Division and Multiplexing (JSDM), where the downlink pre-coder (resp., uplink linear receiver) is split into the product of a baseband linear projection (digital) and an RF reconfigurable beam-forming network (analog), such that only a reduced number $m << M$ of A/D converters and RF modulation/demodulation chains is needed.

In JSDM, users are grouped according to similarity of their channels dominant subspaces, and these groups are separated by the analog beam-forming stage. Further multiplexing gain in each group is achieved using the digital pre-coder. Therefore, it is apparent that extracting the channel subspace information of the M-dim channel vectors from snapshots of m-dim projections, with $m<< M$, plays a fundamental role in JSDM implementation. This algorithms require sampling only specific array elements according to a co-prime sampling scheme, and for a given $p << M$, return a p-dim beam former that has a performance comparable with the best p-dim beam former that can be designed from the full knowledge of the exact channel covariance matrix. They assess the performance of our proposed estimators both analytically and empirically via numerical simulations. They also demonstrate by simulation that the proposed subspace estimation algorithms provide near-ideal performance for a massive MIMO JSDM system, by comparing with the case where the users channel co-variances are perfectly known. [4] Another work is concerned with the channel estimation problem in Millimeter wave (mm Wave) wireless systems with large antenna arrays. By exploiting the inherent sparse nature of the mm Wave channel, we first propose a fast channel estimation (FCE) algorithm based on a novel overlapped beam pattern design. Compared to the existing non-overlapped beam pattern design, the overlap among multiple pilot beam patterns can increase the amount

Volume 1, Issue 6, Pages 53-57, July 2017

of information carried by each channel measurement and thus reduce the required channel estimation time. They develop a maximum likelihood (ML) estimator to optimally extract the path information from the channel measurements. They also propose a novel rate-adaptive channel estimation (RACE) algorithm, which can dynamically adjust the number of channel measurements based on the expected probability of estimation error (PEE). The performance of both proposed algorithms is analyzed. For the FCE algorithm, an approximate closed-form expression for the PEE is derived. For the RACE algorithm, a lower bound for the minimum signal energy-to-noise ratio required for a given number of channel measurements is developed based on the Shannon-Hartley theorem.

The FCE algorithm significantly reduces the number of channel estimation measurements compared to the existing algorithms using non-overlapped beam patterns. By adopting the RACE algorithm, we can achieve up to a 6dB gain in signal energy-to-noise ratio for the same PEE compared to the existing algorithms. [5] The Machine-to-Machine (M2M) communication represents a new paradigm for mobile cellular networks, where a massive number of low-cost devices request the transfer of small amounts of data without human intervention. One option to tackle this problem is obtained by combining Random Beam-forming (RBF) with opportunistic scheduling. RBF can be used to induce larger channel fluctuations and opportunistic scheduling can be used to select M2M devices when their overall channel quality is good. Traditional RBF does not fulfill M2M requirements because overall channel quality needs to be tracked continuously. In order tackle this limitation, a novel codebook based RBF architecture that identifies in advance the time instants in which overall channel quality should be reported, within a coherence time window, is proposed. This opportunistic feedback mechanism reduces signaling overhead and enables energy saving at M2M devices.

A simplified methodology is presented to evaluate the system mean data rate, using for this purpose closed form formulas derived from SNR distribution approximations. Results reveal that the performance loss that is experienced for introducing the proposed modifications to traditional RBF scheme is negligible. The concepts analyzed in this paper provide useful insights, and show that codebook-based RBF with simplified opportunistic scheduling algorithms is an excellent combination to provide wide-area M2M services with low-cost devices and limited signaling overhead. [6] Given a set of users, the scheduler selects more than one user and transmits independent data to them simultaneously by using zero-forcing beam-forming. Taking computational complexity into account, a greedy method finding the best and most orthogonal channel vectors is proposed. Additionally, considering fairness among asymmetric users, they also propose an asymptotically fair scheduling algorithm called PF algorithm. [7]

A. Disadvantages of Existing System

- Lower energy efficiency in Massive MIMO system
- In the Throughput estimation the data rate distribution is not considered
- In Millimeter wave channel estimation the redesign of architecture and protocols make it complex.
- In the existing MIMO system data date is achieved only for limited feedback.
- Feedback overload is high
- Power saving is not considered in the existing system
- Only one user is used in the receiver antenna is used in the receiving side of the system
- Delay is not considered here

3. PROPOSED SYSTEM

Here proposed system is a single-phase feedback algorithm considering the total number of feedback bits fixed. The quantized CDI (Channel Direction Indicator) is used for user scheduling. The CDI of scheduled users is used for beam-forming. The existing method can decrease the sum of feedback bits of ZFBF –SUS scheme with the condition that only a fraction of users are considered. A single cell MIMO broadcast system is considered here and the base station with MT transmitting antennas handles K, number of users. We have assumed here identical users and each user experience Rayleigh flat fading. We have considered here MT as transmitting antennas and MR as receiving antennas such that at receiving section there is only one antenna and four transmitting antenna. Similarly at the receiver side the number of users are increased. Semi orthogonal antenna has been considered. Further, the sum-rate capacity is theoretically investigated. It will be found that there is an improvement of sum-rate capacity considering feedback bits fixed, with an increase in the number of users. Joint resource allocation is used to reduce overhead and failure of network. We use 500 users in the transmitter and in the receiver side and we schedule each user with a allotted time and power

Volume 1, Issue 6, Pages 53-57, July 2017

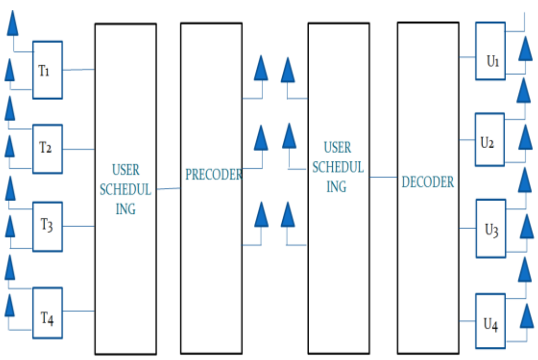
allocation is done. PAPR (Peak-To-Average Power Ratio) is reduced by doing power allocation.

A. Advantages of Proposed System

- Sum rate capacity is increased compared with the existing system
- Only one user is used in the existing system at the receiver whereas in the proposed system many number of users are considered
- The system performance is high
- The power consumption is reduced and more power is saved.
- PAPR (Peak to average power ratio) is reduced

4. SYSTEM MODEL

In the system model we use 500 users at the transmitter and at the receiver. We consider a downlink system here.



In the given block diagram multiple input and multiple output system is considered. T1, T2, T3, T4 are the transmitting antennas and the U1, U2, U3, U4 are the users at the receiver side. Maximum of 500 users are used in our system.

User scheduling is done at both the transmitter and receiver side. Sub carriers are used in both sides to avoid delay. When a user is busy the sub carriers will collect the feedback form the users and sent to the user when it becomes free. Pre coding of data is done at the transmitter side and decoding is done at receiver side.

The capacity analysis is made in a downlink system as given below:

We have considered here M_T as transmitting antennas and M_R as receiving antennas such that at receiving section there is only one antenna and four transmitting antenna. The CDI of each user is defined as

$$\hat{h}_k = \arg\max_{c\in C} |\widetilde{h}_k^H \cdot c| \qquad \widetilde{h}_k = \frac{h_k}{\|h_k\|}$$

The following expected SINR for CQI feedback is

$$\widehat{sinr}_k = \frac{R\,||h_k||^2 \cos^2\Theta k}{1+R\,||h_k||^2 \sin^2\Theta k}$$

The algorithm is described in five steps at the BS:

Step 1: Initially consider m= 1 and **Ko= {1,2, ... K}**
Step2: Selection of m_{th} user is done by

$$\Upsilon(m) = \arg\max_{k\in K(m-1)} \widehat{sinr}_k$$

Step3: Rejuvenate the resting set of users by

$$K_m = \{\, j\epsilon K_{m-1} : |\mathrm{norm}(h_j^H).\mathrm{norm}(h_{\Upsilon(m)})| \leq \epsilon \,\}$$

Step 4 : Upgrade the value of m to m+ 1 and reiterate from step 2 to step 4 while Km is not empty and m < MT. After the selection of user, the quantized channel vectors of selected users are done i.e.

$$S = \{\Upsilon(1), \Upsilon(2), \ldots\ldots\ldots\ldots \Upsilon(N)\} \quad \text{where } N \leq M_T$$

The ZFBF vectors are constructed as

$$\hat{H} = [\,(\hat{H}_{\Upsilon(i)}), (\hat{H}_{\Upsilon(i)}), \ldots\ldots\ldots, (\hat{H}_{\Upsilon(i)})\,]$$
$$W(S) = \hat{H}\,(\hat{H}^H\,\hat{H})^{-1}.$$

The MIMO capacity with CSI at the Transmitter (CSIT) and CSI at the Receiver (CSIR) is given in Equation

$$C = B\,\log_2(1+\mathrm{SINR})\ bps$$

Sum-rate Capacity is defined as taking the average of all channel capacity with respect to its bandwidth

$$C/B = \log_2(1+\mathrm{SINR})\ bps/HZ$$

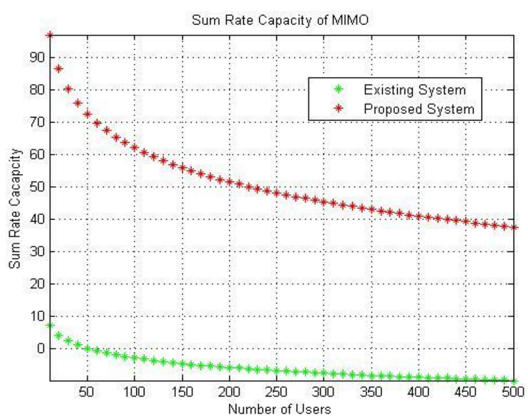
5. RESULTS AND DISCUSSION

In this MIMO system we consider 500 users both at the transmitting and receiver side. The sum rate capacity in increased when compared with the existing system by using zero-forcing beam forming and Semi-orthogonal user scheduling algorithm. Power allocation is also done between the users where PAPR is reduced and hence power is saved more comparing with other systems. In this work the SNR (Signal to noise ratio is found to be low) when users are scheduled accordingly. The data is pre coded at the transmitter as well as the receiver which improves the throughput when the user is busy.

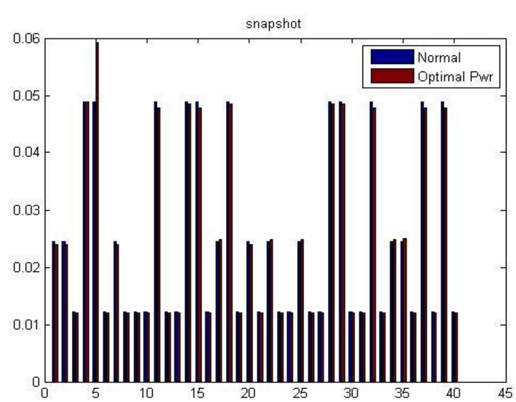
The graphs shown are

- Sum rate capacity Vs SNR
- Sum rate capacity Vs Number of users (500)
- Optimal power Vs Number of users (40)
- Total power Vs Number of users (40)

In the following graph the Sum rate capacity and Number of users are plotted in the X and Y axis respectively. It is found that the sum rate capacity is increased compared with the existing system. The numbers of users are 500 at the transmitting and receiving side.



Here the normal power and optimal power used by the user is shown. 40 users are considered here and the proposed method proves optimal usage of power**.**



6. CONCLUSION

In this work we have introduced two major algorithms such as zero forcing beam-forming and Semi-orthogonal user scheduling and found that the sum rate capacity of a MIMO system is increased when we increase the number of users at the receiving side and compare it with the single user. The feedback overload is reduced by keeping the feedback bits fixed. The energy consumed by the users is low by scheduling the users. PAPR is also reduced. Thus the proposed system has found an incremental relationship between the sum rate capacity and number of users.

REFERENCES

[1] Massive MIMO for Next Generation Wireless Systems. Erik G. Larsson, ISY, *Linköping University, Sweden Ove Edfors and Fredrik Tufvesson, Lund University, Sweden Thomas L. Marzetta, Bell Labs, Alcatel-Lucent, United States.*

[2] An Overview of Massive MIMO: Benefits and Challenges. *Lu Lu, Geoffrey Ye Li, A. Lee Swindlehurst, Alexei Ashikhmin, and Rui Zhang*.

[3] User Throughput Estimation for the Jeongsik Choi, Yong-Hwa Kim, Jong-Ho Lee, Saewoong Bahk, and Seong-Cheol Kim *PF Scheduling Algorithm under MIMO Channel Environments.*

[4] Massive MIMO Channel Subspace Estimation from Low-Dimensional Projections *Saeid Haghighatshoar, Member, IEEE, Giuseppe Caire.*

[5] Millimeter Wave MIMO Channel Estimation using Overlapped Beam Patterns and Rate Adaptation *Matthew Kokshoorn, He Chen, Peng Wang, Yonghui Li, and Branka Vucetic*.

[6] Performance of Quantized Random Beamforming in Delay-Tolerant Machine-Type Communication *Alexis A. Dowhuszko, Graciela Corral-Briones, Jyri H¨am¨al¨ainen, Member, IEEE, Risto Wichman.*

[7] Single-Phase Feedback and Scheduling Algorithm for MIMO Broadcast System for Excelling Sum-Rate Capacity *Barsha Bamali Panigrahi, Sagnika Sahoo, Sudhansu Sekhar Singh.*