Optimization of Power Consumption in MIMO Cellular Networks using Dynamic Semi Definite Relaxation

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Abstract: *In this paper, the optimization of power consumption in MIMO cellular networks to improve the performance using dynamic semi-definite relaxation in terms of signal-to-interference-and-noise (SINR) ratio and optimal transmission power (OTP) is done. A MIMO cellular network where a base station (BS) can transmit data symbols to a fixed mobile station (MS) is considered. The algorithm is designed to decrease the number of active cooperation links and simultaneously optimize the beam forming vectors between the cooperative BSs subject to signal-to-interference-and-noise-ratio (SINR) constraints at the mobile station.We first propose dynamic algorithm based on MATLAB to solve the power optimization problem. Then comparison of the peak OTP, peak SINR, average OTP and average SINR of the proposed scheme with existing one is done.*

Keywords: SINR (Signal to Interference Noise Ratio), OTP (Optimal Transmission Power), SNR (Signal to Noise Ratio), MIMO (Multiple Input and Multiple Output).

1. Introduction

With advancement in technology there is urgent need of optimisation in the existing technology. The idea of using multiple antenna configurations in place of a single antenna has proved to be successful in enhancing data transfer rate, coverage, security and overall performance of radio networks.[1]. One of these configurations focused here more is known as MIMO (Multiple-input Multiple-output). Multiple-Input Multiple-Output (MIMO) technology is a wireless technology that uses number of transmitters and receivers to transfer more data traffic at the same time. To implement MIMO, either the station (mobile device) or the access point (AP) needs to support MIMO.

In the network MIMO system, base stations (BSs) co act on transmission of data to mobile stations (MSs)[1]. Although theoretically attractive, deploying MIMO in a commercial cellular system is basically different as the transmission in each cell acts as interference to other cells, and the entire network is essentially interference-limited. User data and channel state information (CSI) can be shared over the backhaul links to jointly encode and transmit data signals to users with multi cell cooperative processing in order to exploit the inter cell interference, which is known to be a limiting factor in conventional cellular networks[2].

While the problem of interference is inherent to cellular systems, its effect on MIMO is more significant because each neighboring BTS antenna element can act as a unique interfering source, thereby making it difficult for the mobile to estimate and suppress them. With Nr receive antennas; each mobile can only cancel/decode up to Nr different sources using linear techniques [3]. Furthermore, interference is more severe for the downlink because complicated interference suppression techniques are not practical for mobile terminals, which need to be power-efficient and compact. Coordination between users is usually not allowed. The capacity gains promised by MIMO techniques have been shown to degrade severely in the multi-cell environment [4]–[6].

In this we propose optimizar of power. Section I discuss about MIMO and its use in optimization. Section II contains related work. Section III contains the proposed work. Section IV discusses result of simulation. Section V contains concludery result of the proposed work. Section VI discusses work of future expansion.

2. Related Work

Hongyuan Zhang et.al.(2004)[7], In this paper, base station cooperative processing is explored to address the CCI mitigation problem in downlink multicell multiuser MIMO networks, and is shown to dramatically increase the capacity with strong CCI. Both information-theoretic dirty paper coding approach and several more practical joint transmission schemes are studied with pooled and practical per-base power constraints, respectively. Besides the CCI mitigation potential, other advantages of cooperative processing including the power gain, channel rank/conditioning advantage, and macrodiversity protection are also addressed. The potential of our proposed joint transmission schemes is verified with both heuristic and realistic cellular MIMO settings.

Min Li et. al. (2013)[1] consider a network MIMO downlink communication where base stations (BSs) can cooperate on transmission of data symbols to their intended mobile stations (MSs).They assume the data symbols for each user come from a finite alphabet and formulate a novel power optimization problem for the downlink communication

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starting with the binary inputs: they take a symbol detection point of view, impose minimum Symbol Error Probability (SEP) as Quality-of-Service (QoS) constraints at the MSs, and show that the resulting problem is convex. They first tackle the problem via centralized approaches and then propose a distributed algorithm to solve the power optimization problem, where only local communication among the base stations is required.

Arash Khabbazibasmenj, et. al .(2013)[8], addressed the problem of transmit beam space design for multiple-input multiple-output (MIMO) radar with collocated antennas in application to direction-of-arrival (DOA) estimation. The basic idea of the proposed method is to design the transmit beam space matrix based on minimizing the difference between the desired transmit beam pattern and the actual one while enforcing the constraint of uniform power distribution across the transmit array elements.

Fuxin Zhuan,et. al.(2014)[2], proposed a scheme to reduce the backhaul loading as well as the power consumption in MIMO cellular networks .They adopted a backhaul cost metric that considers the number of active directional cooperation links, which gives a first order measurement of the backhaul loading required in asymmetric Multiple-Input Multiple-Output (MIMO) cooperation. We focus on a downlink scenario for multi-antenna base stations and single-antenna mobile stations. The design problem is minimizing the number of active directional cooperation links and jointly optimizing the beamforming vectors among the cooperative BSs subject to signal-to-interference-and-noise-ratio (SINR) constraints at the mobile station. This problem is non-convex and solving it requires combinatorial search. A practical algorithm based on smooth approximation and semi definite relaxation is proposed to solve the combinatorial problem efficiently.

M.Gulam Nabi Alsath et. al.(2014)[9] has presented a single-layer pentaband antenna with very small frequency ratio for urban vehicular communication application and proposed an antenna that is linearly polarized and is designed to cover the navigation and communication frequencies. They we compare with state of the art linear precoding techniques, and demonstrate significant reduction in consumed transmit power attained by the proposed schemes.

3. Proposed Work

In the proposed work, we have created system to normalise the power required for transmission and improving SNR value of signal reaching base station. Here proposed scheme is given below in figure 1.
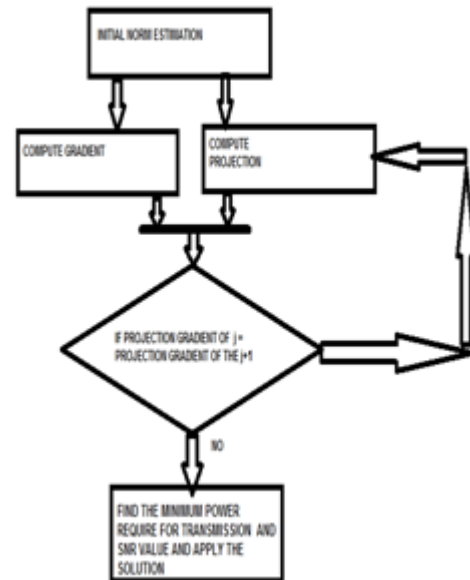

Figure 1: Flow chart of proposed scheme

We perform the norm estimation is being done,in this routing of data from mobile to base station is to have direction of arrival estimation,this estimation is done to reduce gap between actual signal for transmission and desired beam signal. In next step we compute the gradient and projection of signal being sent for transmission .here computation of gradient plays an important role. If value of gradient of previous signal already send is found to be equal to next one to be send then, computation of gradient is again done and signal is not send at that instant. But if value of gradient of previous signal already sends is found to be not equal to next one to be send then, computation of minimum power required to send signal and SNR value is calculated.snr value of signal is defined as signal power to noise power. This depicts the strength of signal received. Computation of optimum transmission power is power or energy involved in the transmission of signal. Lesser is value of OTP more is efficiency of signal transmission. Later on the computer result is chosen and applied to the antenna for minimum power required for sending signal.

This scheme for optimisation is being implement and corresponding simulation result obtained are discussed in next section

4. Simulation Results

During our implementation, we worked on improving the performance of cellular network using dynamic semi-definite relaxation in MATLAB 2010.

A. **Simulation Graph**
We here implement both Semidefinite relaxation and Dynamic Semidefinite relaxation. The analysis of both relaxation schemes performance in terms of:

1) Gradient
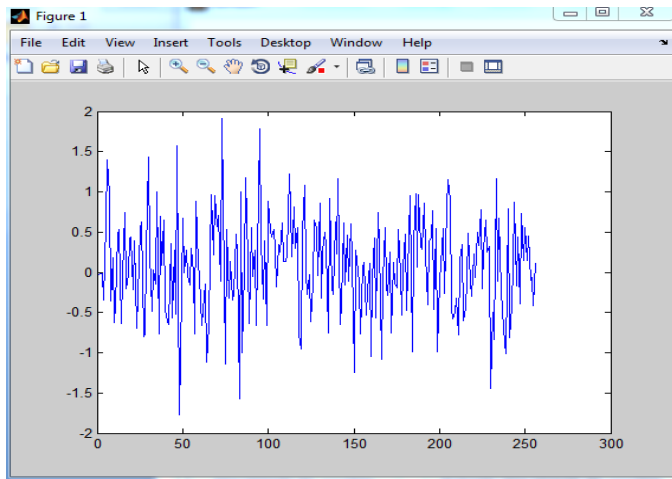2) Projection

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Figure 2: Gradient of Semidefinite relaxation

This shows gradient of Semi definite Relaxation which gives the information about the connectivity in network. The clearly depicts connectivity among different nodes in network.
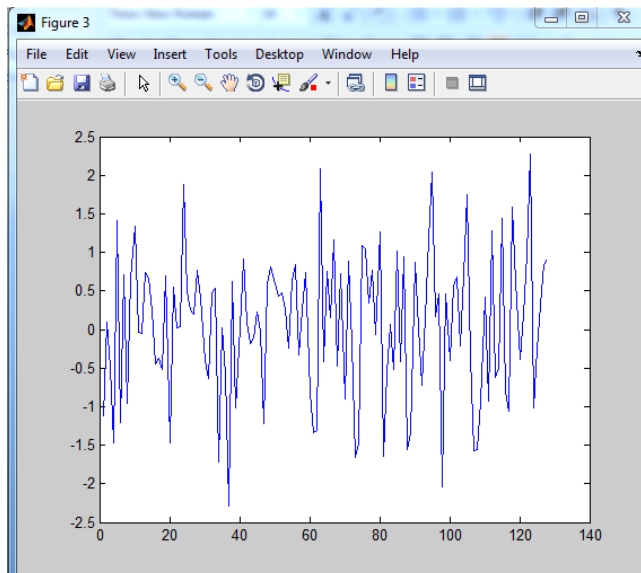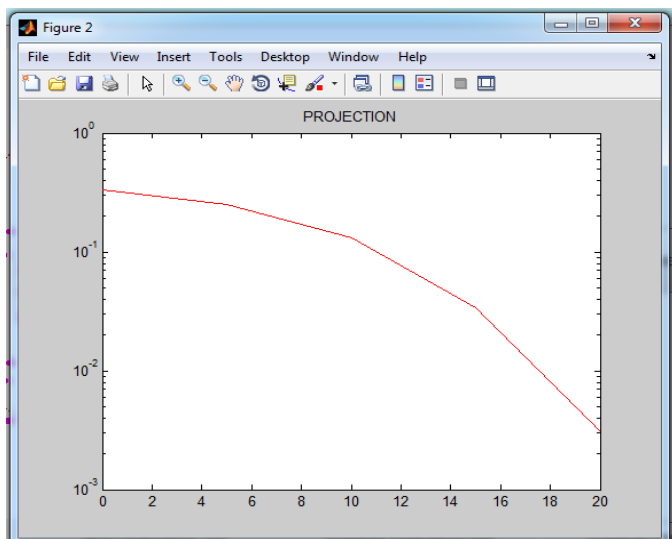

Figure 3: Projection of Semidefinite Relaxation

This shows projection of Semidefinite Relaxation which gives the information about the how much information is being passed from source to sink. The clearly depicts the modes of data travel among different nodes in network.
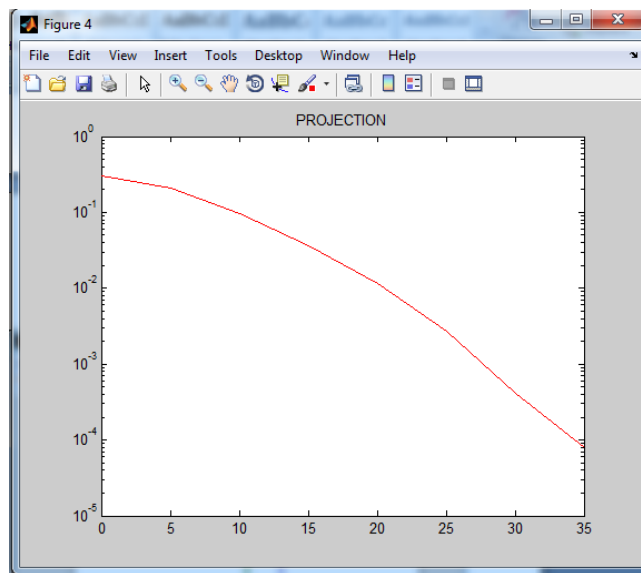

Figure 4: Gradient of Dynamic Semidefinite Relaxation

This shows gradient of Dynamic Semidefinite Relaxation which gives the information about the connectivity in network. The clearly depicts far better connectivity among different nodes in network.

Figure 5: Projection of Dynamic Semidefinite Relaxation

This shows projection of Dynamic Semidefinite Relaxation which gives the information about the how much information is being passed from source to sink. The clearly depicts better the modes of data travel among different nodes in network.

B .Comparison Graphs

Many terms are used to evaluate the performance of Dynamic Semi definite Relaxation with existing Semi definite Relaxation. The following metrics are often chosen to compare the Performance of various routing protocols:

1) Optimal transmission Power

The optimal common transmits power for wireless networks. In particular, the optimal common transmit power has been defined as the minimum transmit power sufficient to preserve network connectivity. An analytical closed-form expression for the optimal common transmits power is derived. This is

particularly useful for network planning as it allows one to determine the minimum power to use while keeping the network connected.
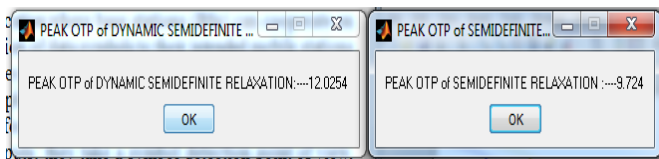

Figure 6: Peak OTP Comparison

Peak comparison of OTP shows that there is gradual decrease in power required to perform the same set of sending from source to destination. The decrease in power is by 19.16% that again indicate increase in performance of Dynamic Semidefinite Relaxation in comparison with existing ant Based Routing Algorithm.
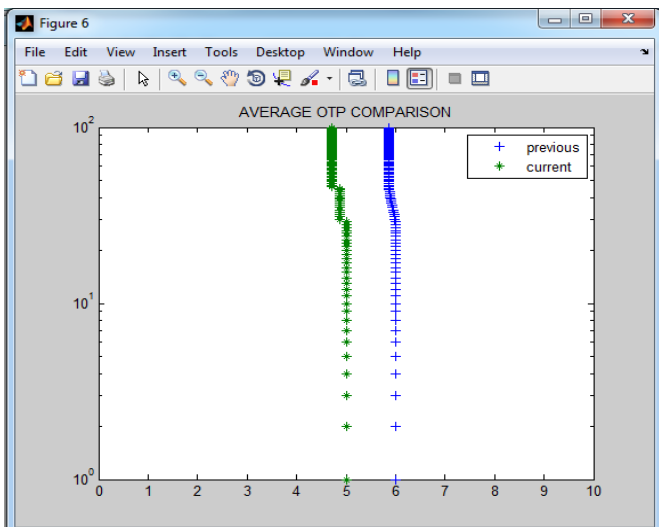

Figure 7: Average OTP Comparison

In the figure 7, average OTP comparison shows that less transmission power is required to perform same set of task of sending data from Source to sink at the centre. Lesser is Power of transmission more is energy saved.

2) SNR

In analog and digital communications, signal-to-noise ratio, often written as S/N or SNR, is a measure of signal strength relative to unwanted interference or noise. The ratio is usually measured in decibels (dB).Signal-to-noise ratio is sometimes used informally to refer to the ratio of useful information to false or irrelevant data in a conversation or exchange.

If the incoming signal strength in microvolts is V_s, and the noise level, also in microvolts, is V_n, then the signal-to-noise ratio, S/N, in decibels is given by the formula
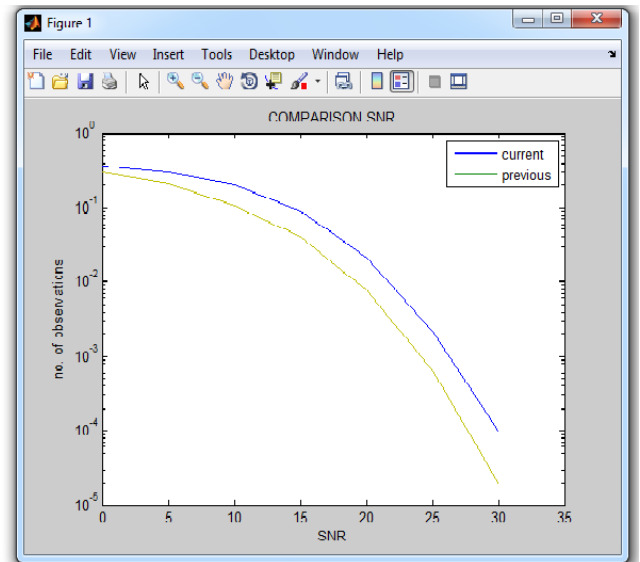$$S/N = 20 \log_{10} (V_s/V_n)$$

Figure 9: Comparison SNR

The comparison SNR graph shows that Dynamic Semidefinite relaxation has greater slope than semidefinite relaxation. Better performance is achieve in terms more of signal is transferred than to noise as comparison to previous algorithm

5. Conclusions

In this paper, an optimisation technique for less power consumption is created. The algorithm which is used for reducing power requirement has given accurate results and is more efficient than previous algorithms. The proposed Dynamic Semidefinite Relaxation improves the OTP, robustness and SNR. The efficiency of proposed scheme is shown to be better than other existing scheme. The proposed Dynamic Semidefinite Relaxation uses an optimal path routing and fast route discovery. The established paths provide reliable, shorter and faster communication. Simulation results show that the proposed protocol provides reliable and power efficient routing by attaining high Signal to Noise ratio and low energy consumption compared to the existing Semidefinite Relaxation.

6. Future Work

For future work more addition to this work can be done by using more dynamism in relaxation scheme. Further, working on the implementation to improve the algorithm can be done. Further investigations include experiments with high network load and multimedia data. Additionally, analysis of the maintenance of the pheromone concentration is needed. There are different ways to manipulate the performance of Dynamic Semidefinite Relaxation, like routing scheme.

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